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LOGISTIC SUPPORT IN THE VIETNAM ERA

MONOGRAPH 13

MAINTENANCE

A REPORT
BY THE JOINT LOGISTICS REVIEW BOARD

361

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

18 DEC 1970

SS
INSTALLATIONS AND LOGISTICS

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Paul H. Riley

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Deputy Assistant Secretary of Defense
(Supply, Maintenance & Services)

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CHAPTER I
INTRODUCTION

1. BASIS FOR STUDY. Maintenance, as a process within the total logistics system, was examined by the Joint Logistics Review Board (JLRB). The JLRB Terms of Reference stated: "The Board will have broad authority to determine the areas and depths of its review, but particular attention will be directed to the following functional areas: ...Maintenance support to include in-country, offshore, and CONUS...." This examination recognized the mutually supportive relationship of commercial and military resources to accomplish materiel maintenance.

2. SIGNIFICANCE OF MAINTENANCE. The readiness posture of the Armed Forces is dependent upon an effective maintenance function. In fact, the operationally ready rate of combat essential equipment is frequently the measure of maintenance effectiveness. The four Services maintenance work force composed of both military and civilian personnel provide the required maintenance. This work force currently exceeds one million, representing 28 percent of the total Department of Defense work force.

3. STUDY OBJECTIVES. The Joint Logistics Review Board study of maintenance had three primary objectives:

a. To review Service maintenance performance during the Vietnam era to identify strengths and weaknesses.

b. To evaluate maintenance effectiveness during the Vietnam era.

c. To identify lessons learned and to make recommendations for improvement as appropriate.

4. SCOPE. An in-depth review of the maintenance organizations and operations of each of the Services during the Vietnam era was conducted. This review identified areas for improvement by individual Services and areas for attention of the Joint Chiefs of Staff and the Office of the Secretary of Defense. Specific conclusions, recommendations, and observations concerning effectiveness, strengths, weaknesses, and lessons learned are discussed. Five special studies were conducted: Deferred Maintenance, Maintenance Support Considerations During Concept and Development, Depot Maintenance, Maintenance Manpower, and Automatic Data Processing Systems.

5. EXCLUSIONS. This monograph does not examine maintenance associated with real property or facilities. This subject is contained in the Advanced Base Facilities Maintenance monograph. The examination of communications-electronics maintenance, as part of the overall review of logistics effectiveness in Vietnam, indicated that the basic problems were not significantly different from those associated with weapon systems; therefore, separate treatment is not given in this area.

6. ORGANIZATION OF THE MONOGRAPH. This monograph is composed of thirteen chapters and five appendixes. Chapter II is a general description of current maintenance systems in the Department of Defense. Chapters III through VI describe the maintenance support within the individual Services during the Vietnam era. Chapters VII through XII are special studies and Chapter XIII is a summary with conclusions, recommendations, and observations. The first three appendixes support Chapter VIII; the remaining two appendixes contain reference material.

CHAPTER II
GENERAL DESCRIPTION

1. INTRODUCTION

a. The response to letters of inquiry by the Joint Logistics Review Board provided a wide range of observations for consideration in the review of the logistics area. The limited expressions on maintenance support (6 of 354) would, without analysis, tend to obscure the role of the maintenance process within the total logistics system. Subsequent Service reports and briefings substantiated the premise that maintenance was a problem often submerged under other logistics areas such as supply, personnel, or facilities. This review is designed to place maintenance planning and support in proper perspective to Service mission objectives and materiel readiness.

b. The Office of Secretary of Defense develops the guidelines for maintenance management within the Department of Defense (DOD). The roles and missions of the Services delineate the concepts of organization, operations, and management techniques which each can apply to the maintenance function. Each Service has maintenance systems and organizations primarily developed to respond to its assigned mission. The fundamental maintenance objective of the Services is to maintain the maximum degree of equipment readiness within the resource constraints that are imposed for economic or other reasons.

2. MAINTENANCE RESPONSIBILITIES, CONCEPTS, AND OBJECTIVES

a. Office of Secretary of Defense

(1) Maintenance management responsibilities of the Office of Secretary of Defense (OSD) are assigned to the Assistant Secretary of Defense (Installations and Logistics). The office of prime responsibility within the Secretariat is the Directorate for Maintenance Policy under the Deputy Assistant Secretary of Defense (Supply, Maintenance, and Services). The role of this office is the formulation of policy and broad procedural guidelines. It pursues a policy of providing programs that will improve direction, technical supervision, management control of major maintenance programs and activities, and integrated logistic support. These programs place emphasis upon the effective use of operation plans, budget, costs, and fiscal data to promote effective and efficient use of commercial and military resources for accomplishment of materiel maintenance requirements. An objective is to organize depot maintenance activities in a manner to support peacetime readiness and the initial phase of a national emergency or war. Government-owned and operated depot maintenance activities within the Department of Defense exist to provide an ensured level of technical competence and maintenance capacity.

(2) The Defense Equipment Maintenance and Readiness Control has a contributory role in maintenance management policy toward improving maintenance and readiness of systems and equipment. Its members are senior military and civilian representatives of the military departments, Joint Chiefs of Staff, Defense Supply Agency, and the Office of the Secretary of Defense. The Council Chairman is the Deputy Assistant Secretary of Defense (Supply, Maintenance, and Services). The Council serves in an advisory capacity to the Assistant Secretary of Defense (Installations and Logistics). The surveillance of maintenance by OSD is based on five programs designed to provide detailed information on maintenance operations and on the status of equipment readiness. These are Equipment Distribution and Condition (EDAC)—Measuring and Reporting System; Uniform Depot Cost Accounting and Production Reporting System; Depot Maintenance Support Programming Policies; Equipment Maintenance Management Information System (under development); and the Logistics Performance Measurement and Evaluation System.

(3) The OSD, in its efforts to achieve maximum systems and equipment readiness, emphasizes integrated logistic support planning. This is a methodology which requires the interrelationship of support elements, planned maintenance, logistic support personnel, technical logistical data and information, support equipment, spares and repair parts, facilities and contract maintenance to ensure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle.

(4) On 21 May 1968, the DOD Industry Committee for Integrated Logistic Support was established to assist in determining and demonstrating the value of applying logistic support concepts to the early development of weapons systems. This committee submits its cases and recommendations to the Assistant Secretary of Defense (Installations and Logistics).

(5) The review of DOD directives and instructions relatable to maintenance reveals a pattern without regard to multiple application. Of the 85 directives and instructions governing policy, concepts, and objectives, 38 deal with depot and contract maintenance, 24 support manpower or personnel, 12 involve maintenance considerations during concept and development, 6 are oriented toward automatic data processing, and 5 apply to deferred maintenance. The maintenance management objectives of OSD are promulgated as an annual program.

b. Joint Chiefs of Staff

(1) The Joint Chiefs of Staff (JCS), in accordance with JCS Pub 2, maintain cognizance of the readiness of equipment within the Services. The JCS take action on specific items when requested by either unified commanders or higher authority and in connection with the appropriate Service or Services to resolve conditions of equipment readiness that adversely affect the operational capability of the unified commander. In case of disagreement on interservice and interdepartmental logistic support (including maintenance), the JCS will, with the advice of the unified commander and the military department concerned, determine the assignment of responsibilities to the various Services. There were no known cases where JCS made an assignment of maintenance responsibility to the Services.

(2) The Deputy Director for Logistics (J-4) of the Joint Chiefs of Staff is a member of the DOD Equipment Maintenance and Readiness Council and provides membership on ad hoc study committees investigating conditions affecting maintenance and readiness of equipment.

(3) Joint Logistics Planning and Policy Guidance (JCS Pub 3) has been authorized for use throughout the Department of Defense for ensuring and maintaining an alert posture of logistics readiness.

c. Commanders of Unified Commands. The logistics responsibilities for maintenance of the commanders of unified commands are directed primarily toward efficient utilization of resources and elimination of unnecessary duplication of facilities and overlapping of functions among the Service components. The Commander in Chief, Pacific (CINCPAC), acted as area coordinator and as a reporting activity for interservice logistic support agreements.

d. Military Services

(1) The Services have the basic responsibilities for the maintenance of their equipment, and have units and activities organized, equipped, and trained for that purpose. The maintenance concepts of the Services are a continuance of the Department of Defense concepts with elaboration on such factors as mission effectiveness, equipment readiness/availability, reliability, maintainability, and standardization. The accepted concept of maximum maintenance to be accomplished as far forward as possible, within capabilities and resources, proved effective in supporting forces during the Vietnam era but required a large number of personnel, new facilities, and supply support characterized by extensive ranges of line items. All Services are reexamining this concept against improved management techniques and advances in transportation and communications. The possibility of reducing costs of materiel resources required in combat areas stimulate these reexaminations.

(2) The basic maintenance objective of the Services is to provide and maintain equipment to using activities in an operationally ready condition and to do so at the least possible cost.

(3) Maintenance within each Service is performed on three levels: organizational, intermediate, and depot. The organizational level is performed principally by military personnel. The intermediate level is also performed by military personnel, with the exception of the Army which mans this level in CONUS installations with a preponderance of civilians. The depot level is performed principally by civilian personnel in all Services.

(4) Maintenance organizations are specifically tailored by the individual Services in order to provide the best possible maintenance support in concert with the missions assigned.

(5) The experiences of Vietnam and the examples of accomplishments and of changes that were made provided the basis for arriving at strengths, weaknesses, and lessons learned. In so doing, however, there is the danger of assuming that what was done to support the Vietnamese conflict is applicable to all future planning and should, therefore, be adopted. The buildup of forces and the tempo of action in Vietnam were controlled responses by the United States. There was no interruption of intertheater lines of communication, as the United States dominated both the air and the sea. Land areas in Vietnam, although not under complete control of the United States and its allies, were made usable at our discretion. Because of this situation, support for combat units in Southeast Asia was built up at an orderly rate compared to what would have been required had the enemy controlled the situation. It is in this context that the Service strengths, weaknesses, and lessons learned are portrayed.

CHAPTER III
ARMY MAINTENANCE

1. GENERAL

a. Background. The Army is organized, trained, and equipped for prompt and sustained combat operations in a land environment. In coordination with the other Services, it also provides Army forces for joint amphibious and airborne operations. The Army's ability to perform in the full spectrum of warfare—cold, limited, and general—and in various operational environments requires that the logistic concept be designed for flexibility in response to Army requirements. The present maintenance concept is designed to provide the Army in the field with the support necessary to maintain the desired combat readiness.

b. Concept

(1) The current organizational concept for providing combat service support to the Army in the field is embodied in FM 54-8, The Administrative Support Theater Army-1970 (TASTA-70). This system is designed to be flexible so that it can be tailored to support a wide variety of combat forces ranging from an independent brigade to one or more field armies operating under several conditions of warfare. The maintenance concept developed under TASTA-70 has the paramount consideration of keeping all equipment in a prescribed state of readiness.[1]

(2) The primary objective of the maintenance organization of the Army is to support the equipment of the Army in the field. The support must be flexible enough to meet changing demands. This is achieved through the use of the following four categories of maintenance.[2]

(a) Organizational Maintenance. Organization maintenance is performed by the using organization and consists of inspecting, cleaning, servicing, preserving, lubricating, adjusting, and replacing minor parts.

(b) Direct Support Maintenance. Direct support (DS) maintenance is performed by maintenance activities in direct support of using organizations and consists primarily of repair and replacement of unserviceable parts, and with repair parts supply to using organizations. Repaired equipment is returned to user.

(c) General Support Maintenance. General support (GS) maintenance is performed by maintenance activities in support of area supply operations and consists primarily of repair and replacement of unserviceable parts beyond the scope of direct support maintenance. Repaired equipment is usually returned to supply channels. GS maintenance units provide backup and overflow support to DS maintenance units by accepting work that is beyond the capability or workload capacity of direct support.

(d) Depot Maintenance. Depot maintenance is performed by designated activities having a capability beyond that of direct and general support maintenance units. Consisting of major overhaul or complete rebuilding of parts, subassemblies, or entire major items, depot maintenance is accomplished with extensive shop facilities, equipment, and personnel of higher skill level that are not available at the lower levels of maintenance. Rebuilt equipment is usually returned to depot stocks for reissue.[3]

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[1] Department of the Army Manual FM54-8, (TEST) The Administrative Support, Theater Army (TASTA-70), March 1967.
[2] Department of the Army Manual FM 38-1, Logistics Management, March 1969.
[3] Department of the Army Regulation 750-1, Maintenance Concepts, June 1967.

c. Equipment

(1) The Army maintenance system concerns itself with a massive inventory of materiel worth approximately $24 billion.[4] The varying and increasing complexity of this equipment, together with the wide differences in size, its application and utilization in environmental conditions of extreme heat, cold, dust, or mud, and its operation on unimproved roads and cross-country operations, not only creates difficulties in the maintenance of this equipment but creates problems in the evacuation and recovery to each category of maintenance.

(2) The following examples are indicative of the types of equipment the Army maintains: tactical vehicles, self-propelled guns, wheeled vehicles, small arms, artillery weapons, missiles and launchers, construction, river crossing, railway, electronics and communications, ammunition, medical, cryptographic, aircraft, avionics, and marine craft.[5] The density of selected items of equipment supported in Vietnam as of 30 September 1969 is shown in Table 1.

TABLE 1

U.S. ARMY IN VIETNAM—EQUIPMENT DAYS AVAILABLE
(30 SEPTEMBER 1969)

Commodity	Approx. Quantity On Hand	Possible Days	Available Days
Artillery	2,500	90	86
Combat Vehicles	3,500	90	81
Tactical and Support Vehicles	47,000	90	82
Electronic and Communication Equip.	20,000	90	86
Special Purpose Equipment	11,500	90	77
Aircraft Rotary Wing	3,000	90	71
Aircraft Fixed Wing	700	90	75

Source: United States Army, Pacific, Letter: GPLO-MO, Maj. Gen. Durrenberger to Lt. Gen. Hurlbut, Maintenance Information on Vietnam 1968-1969, 30 December 1969.

d. Maintenance Personnel

(1) As of July 1968 there were approximately 315,000 military and civilian personnel involved in performing the maintenance function in the Army.[6]

(2) As of the end of 1969, personnel performing depot maintenance functions numbered approximately 31,900, an increase of approximately 2800 over 1965.

(3) At the end of 1969, depot maintenance personnel were distributed as follows:[7]

[4] Department of the Army, Deputy Chief of Staff for Logistics, Letter, Depot Maintenance Information, 2 December 1969.
[5] Department of the Army Manual, FM 38-1, Logistics Management, March 1969.
[6] Department of Defense, Office of Assistant Secretary of Defense (Installations and Logistics), Report of the Long Range Logistics Manpower Policy Board, February 1969.
[7] Department of the Army, World Wide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions, 1966-69.

Location	Personnel	Depots
CONUS	22,000	16
USAREUR	6,100	6
USARPAC	3,800	3

(4) Military personnel performing intermediate (direct/general support) maintenance in Vietnam as of September 1969 accounted for approximately 18,000 personnel.[8]

(5) Contract maintenance personnel being utilized in Vietnam at the end of FY 68 numbered approximately 23,000.[9]

e. Policies

(1) The repair of equipment will be performed at the lowest category of maintenance authorized by the maintenance allocation charts, commensurate with the time required for accomplishing the repair, available technical skills, tools, and test and support equipment authorized in Tables of Organization and Equipment (TOE) or Tables of Distribution and Allowances (TDA).

(2) Each maintenance activity will perform the authorized maintenance for which it is responsible.[10]

(3) The maintenance system is organized to ensure provision of adequate maintenance support as close to the using units as practicable.[11]

(4) The mobility of maintenance units must be compatible with the forces they support. Maintenance units supporting highly maneuverable tactical forces must possess sufficient mobility to permit rapid movement to another location when distances preclude satisfactory performance of function.[12]

(5) Whenever practical, maintenance will be accomplished under the Inspect and Repair Only as Necessary (IROAN) principle.[13]

(6) The Department of the Army will develop or retain a level or organic depot maintenance capability and capacity to provide an expandable base for support of mission-essential materiel.[14]

(7) The TOE-organized DS and GS maintenance units within the continental United States (CONUS) will be assigned operational support missions as part of the CONUS training base.[15]

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[8] Department of the Army, Force Accounting System Active Army Troop List as of September 1969.

[9] U.S. Congress, House of Representatives, 90th Congress 2d Session, Committee on Appropriations, Military Personnel Hearings, 1969.

[10] Department of the Army Regulation 750-5, Organization, Policies and Responsibilities for Maintenance Operations, September 1967.

[11] Department of the Army Manual FM 38-1, Logistics Management, March 1969.

[12] Department of the Army Manual FM 29-20, Maintenance Management in Theaters of Operation, July 1968.

[13] Department of the Army Regulation 750-5, Organization, Policies and Responsibilities for Maintenance Operations, September 1967.

[14] Department of Defense Directive 4151.1, Policies Governing the Use of Commercial and Military Resources for Maintenance of Military Materiel, 18 July 1960.

[15] Department of the Army Regulation 750-5, Organization, Policies and Responsibilities for Maintenance Operations, September 1967.

f. Responsibilities and Organization

(1) At Department of the Army level, the Deputy Chief of Staff for Logistics is assigned Army General Staff responsibility for the maintenance policy and support planning of the Army.[16]

(2) The Commanding General, U.S. Continental Army Command, will provide training as required to ensure that trained operators and maintenance personnel are available at the time newly developed or procured items are issued to troops. He will, in addition, furnish development agencies with information regarding the adequacy of current service training to provide personnel qualified to perform those specific tasks assigned by the maintenance allocation charts.[17]

(3) The Commanding General, United States Combat Developments Command, will ensure that the maintenance concept based on prescribed policy provided in the qualitative materiel requirement, or small development requirement is realistic and sufficiently definitive to furnish essential data required by developing and other participating agencies. He will examine TOE and Military Operational Specialty (MOS) descriptions and structure to ensure that TOE includes only the minimum essential operations and maintenance personnel appropriately qualified to maintain new equipment when issued.[18]

(4) The Commanding General, United States Army Materiel Command, will ensure that all elements of integrated maintenance support for newly developed or procured items of equipment, assemblies, or systems are available at the time these items are issued to the user.[19]

(5) Commanders at all levels, down to and including squad and section leaders, are responsible for the proper maintenance of materiel.[20]

g. Conceptual Changes

(1) During the Vietnam era, maintenance policy, support structures, and procedures were well defined and documented. Evolutionary developments in maintenance support techniques are evidenced throughout this narrative. Changes were motivated by combat experience, increasing equipment complexity, shortage of maintenance skills, and increased dependence on maintenance programs as a source of supply. New technology available to the manager, including automated data systems and improved communications and transportation facilities made changes possible. Examples of maintenance management technology under development are highlighted in paragraph 3n, Army Logistics Offensive.

(2) Until recent years, the maintenance support of the U.S. Army was provided by units of the Technical Services: Chemical, Engineer, Medical, Ordnance, Quartermaster, Signal, and Transportation. Units organized and trained by the Technical Services performed support operations at the field level under doctrine and detailed procedures developed by each individual Service. The system contained inherent disadvantages because of its fragmentation into seven virtually autonomous agencies. It was inconvenient to combat and combat support units, since they were forced to depend on more than one source for maintenance support. In some instances, all seven Technical Services were involved in the support of a single end item, such as a tank.[21]

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[16] Ibid.
[17] Department of the Army Regulation 750-6, Maintenance Support Planning, August 1964.
[18] Ibid.
[19] Ibid.
[20] Department of the Army Regulation 750-5, Organization, Policies and Responsibilities for Maintenance Operations, September 1967.
[21] Department of the Army Manual FM 38-1, Logistics Management, March 1969.

(3) Providing maintenance support under the Technical Services concept was eliminated as a result of a conceptual study which had its early development in 1962. The study, titled Combat Support To Army (COSTAR), eliminated from the maintenance standpoint the Technical Services maintenance units (except Medical) and created a functional organization that was compatible with the existing divisions and the commodity oriented CONUS base. It eliminated duplication of maintenance training, skills, tools, and test equipment. COSTAR was designed to reduce the span of control of the force commander, particularly in the areas of combat service support, to obtain greater responsiveness to user requirements, to provide to the maximum extent one source where the user could obtain the required maintenance support, and to provide an organization capable of being tailored to varying force structures and environments.

(4) Maintenance units deployed to Vietnam in 1965 and early 1966, however, were still organized under the Technical Services concept. These units were oriented toward the repair of specific Ordnance, Signal, Quartermaster, Transportation, Engineer, and Chemical equipment. The subsequent reorganization of logistic units in Vietnam in late 1966 to encompass the COSTAR concept was a large undertaking that required deactivation of old units, activation of new units, realignment of functions, realignment of personnel, and redistribution of tools and equipment.[22]

(5) Currently, reorganization under the COSTAR concept has been superseded by a new concept, The Administrative Support Theater Army—1970 (TASTA-70). TASTA is currently being implemented by degrees with full implementation awaiting the completion of the automated data processing system upon which TASTA is highly dependent.

2. MAINTENANCE SUPPORT DURING THE VIETNAM ERA

a. Scope. The following information pertains to maintenance support during the Vietnam era, with emphasis on Vietnam, and indicates chronologically, events and actions that took place in-country (Vietnam), offshore (Japan, Okinawa, and Taiwan), and in CONUS.

b. In-Country

(1) The decisions made in March 1965 to commit major United States combat forces in Vietnam required immediate action toward a massive logistics buildup. At the time of the initial deployment of the United States ground forces (March 1965) the Army logistics support system in Vietnam consisted of an extremely small organization functioning to support the needs of approximately 16,000 U.S. Army personnel.[23] The force development organization was confronted with the problem of creating a system that would support an aggregate force of a half million fighting men, coupled with the ability to expand when necessary.

(2) Maintenance support in the first half of CY 65 consisted mainly of small maintenance detachments for both ground and aviation equipment. Units larger than detachment size consisted solely of transportation aircraft maintenance and four support companies. The reason for the larger aircraft maintenance units was the rapidly expanding size of the in-country Army aircraft fleet.[24]

(3) By July 1965, approximately 660 aircraft were operating throughout from Hue Phu Bai in the North to Soc Trang in the South. Fixed wing aviation units had direct support maintenance capability organic to the operating units. Nondivisional helicopter companies also had direct support detachments located with them while separate brigades had organic direct support aircraft maintenance platoons. Medical units, artillery units, separate helicopter units, plus various other low density aircraft units, did not have DS aircraft maintenance organic to

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[22] U.S. Army, Pacific, Annual Historical Summary Part I General Summary, 1 July 1965 - 31 December 1966.
[23] U.S. Army, Pacific, Commander in Chief, Pacific/Military Assistance Command, Vietnam, Report on the War in Vietnam, 1968.
[24] U.S. Army, Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

their units, and depended upon the maintenance services of the recently organized 34th General Support Group (Aircraft Maintenance and Supply).[25]

(4) Army ground units requiring maintenance support in July 1965 consisted of 15 battalions of Infantry, Artillery, Engineer, and Signal troops plus other units of squadron or company size. Maintenance support was normally attached from the parent unit or furnished by attached separate units provided for the purpose of independent mission accomplishment.

(5) In December of 1965, as combat and combat support units increased, maintenance problems with specific items of equipment became evident. The high deadline rates of engineer construction and materials handling equipment caused a great deal of concern, since base construction and vessel discharge demanded the maximum availability of both. A problem that occurred sporadically throughout this time frame was the introduction of some test and special equipment without sufficient supporting tools, publications, and repair parts.[26] Often there were no personnel in-country qualified to maintain the equipment. It became apparent that special and test equipment items were in some cases off-the-shelf purchases which had not had a prior period of field testing under simulated Vietnam environmental conditions. Paragraph 4h provides an example of the type of special equipment in question.

(6) By 1966, maintenance support was characterized by the heavy overloading of DS maintenance units whose normal mission was to repair and return equipment to using units. In order to alleviate the situation, GS maintenance units whose normal mission was to repair and return items to supply channels were forced to assume direct support missions. The resultant lack of general support capability created problems regarding the repair of extensively damaged equipment. To assist and provide relief in this area, the Army undertook two actions:

(a) A program was developed to standardize bulldozers and materials handling equipment (MHE), with the ultimate goal established at three makes/models of bulldozers and a single make/model for each of the five types of MHE required.[27] Attainment of this goal was aggressively pursued and by January 1967 MHE had been reduced to 10 makes and models, despite the fact that in-country density had increased to 1,486 units.

(b) The Army renovated and deployed to Vietnam during the first quarter of 1966 a Floating Aircraft Maintenance Facility (FAMF).[28] This floating repair shop eventually accomplished not only aircraft component repair but also manufactured non-aircraft repair parts for other major end items. Paragraph 3b elaborates upon the major contribution of the facility in reducing overall Not Operationally Ready Supply (NORS) rates.

(7) As the input of combat and logistic units gained momentum in 1966 it became obvious that the maintenance capacity in terms of military maintenance organizations could not hope to keep up with the rapidly increasing maintenance workload.

(8) The shortage of military personnel at the intermediate level, caused by Vietnam military manpower ceilings coupled with the decision not to call up reserve units, gave rise to the extensive use of contract maintenance to augment the military capability.[29] Initially, contracts were let to accomplish vehicle and watercraft repair at the GS and depot levels as well as specific aircraft modifications.

(9) Aircraft intermediate maintenance support capacity in late 1966 and early 1967 became inadequate as the input of new aviation units outpaced the input of aircraft maintenance

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[25] U.S. Army, Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of the U.S. Army Logistics System in RVN, July 1965 to August 1969, Annex F, Aviation Supply System, 31 August 1969.
[26] Ibid.
[27] Army Materiel Command, Arsenal for the Brave; A History of the AMC, 1962-1968.
[28] Department of the Army, Buildup Progress Report, August 1965-July 1968.
[29] U.S. Army, Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of the U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

units. DS and GS maintenance units were being activated and trained in CONUS but their deployment was delayed owing to shortage of equipment and experienced personnel. To offset the shortage of aircraft maintenance units, additional contractor personnel specializing in airframe and electrical repairs were acquired. However, as time progressed, contractor personnel became involved in every facet of the intermediate level aircraft maintenance operation. The principal reason for the overall involvement was the inability of the CONUS rotational base to supply adequately skilled aircraft repairmen concurrent with the rapid influx of helicopters.

(10) Table 2 indicates the large and meteoric expansion of the Army aircraft fleet in Vietnam.

TABLE 2

DENSITY OF U.S. ARMY AIRCRAFT (MONTHLY AVERAGE)

Density	CY 65	CY 66	CY 67	CY 68	CY 69
Fixed Wing	183	353	444	557	593
Rotary Wing	340	1380	2076	2313	3184
Total	523	1733	2520	2870	3777

(11) Table 3 depicts the increase in contract personnel from FY 65 through FY 70.

TABLE 3

CONTRACT MAINTENANCE MANNING LEVEL
ARMY AVIATION, REPRESENTATIVE OF SOUTH VIETNAM

Company	FY 65	FY 66	FY 67	FY 68	FY 69	FY 70
Lockheed Aircraft Co.	--	--	--	100	232	257
Lear Siegler, Inc.	--	--	457	624	832	733
Dynalectron Corp.	34	239	550	847	1056	872
Total	34	239	1007	1571	2120	1892

Source: U.S. Army, Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of the U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

(12) Types of skills purchased and number of civilian personnel engaged in each skill are shown in Table 4. Data indicate the percentage of the total civilian work force engaged in each skill during the period FY 67-69.

(13) Figure 1 depicts the aircraft flying hour versus Not Operationally Ready Supply (NORS) rates for FY 67-69.

(14) During 1967 greatly expanded logistic support was challenged by additional ground equipment and aircraft which were committed to meet expanding requirements of the force increases, a condition that placed a substantial load on the Army's maintenance effort.

TABLE 4

PERCENTAGE OF CIVILIAN WORK FORCE BY SKILL

Classification	Percentage of Work Force
Senior (Systems Specialist Mechanic)	32
Electronic Technician	27
Airplane General Mechanic	20
Lead Men	10
Inspector	4
Mechanic I	4
Mechanic II	2
Engineer	1

Source: Department of the Army, Deputy Chief of Staff Logistics, Memorandum, Contractual Services for Aircraft Maintenance in Vietnam, 27 August 1969.

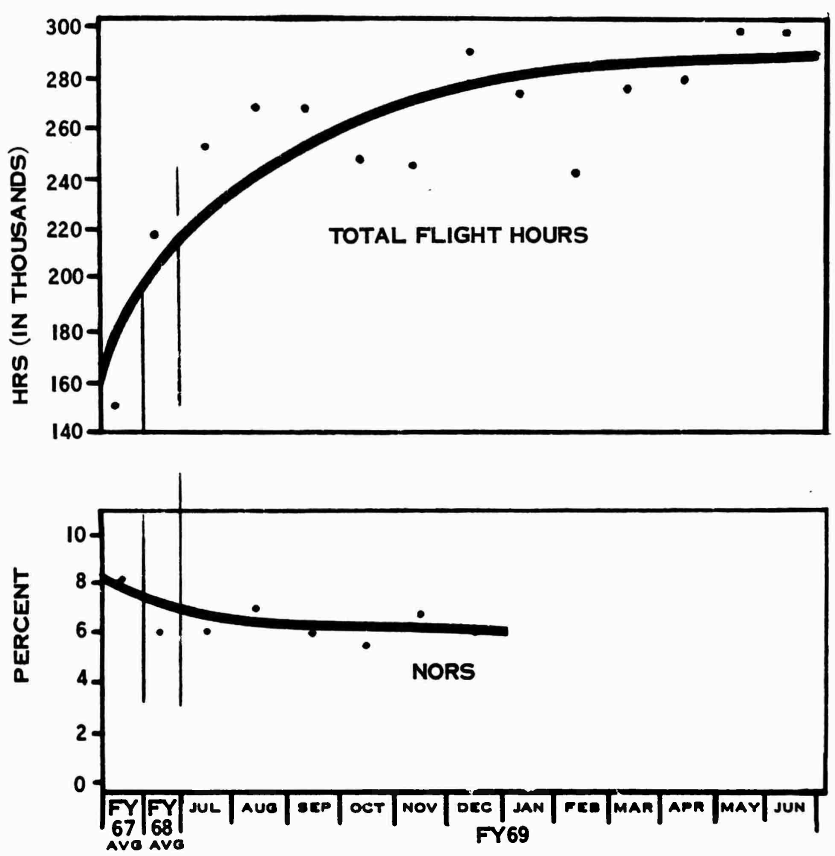

FIGURE 1. COMPARISON OF AIRCRAFT FLYING HOURS AND NOT OPERATIONALLY READY–SUPPLY (NORS) RATES

Source: U.S. Army, Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of the U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

(15) The increase in combat operations with its inherent increased damage to equipment led the logistic planners to the development of a system for the positive control of critical end items and components that resulted in the implementation of Closed Loop Support (CLS). Initiated in 1966 and formalized in 1967, CLS provided as close a balance as possible between equipment availability and equipment requirements.[30]

(16) One of the problems that occurred during this time frame and became more serious as time went on was the mechanical difficulty encountered with the new multifuel engine (paragraph 3g). The engine, installed on an Army-wide basis, was used extensively in Vietnam where it received its "baptism under fire" and proved to be as cantankerous as the enemy.

(17) In the closing months of 1967, deployment of TOE maintenance units leveled off. Operational reports from the U.S. Army, Vietnam (USARV), consistently praised the overall performance of COSTAR maintenance units trained and deployed by CONARC. However, USARV reported that maintenance personnel arriving as individual replacements were adequately trained but needed practical experience in CONUS prior to being shipped to Vietnam. The shortage of experienced maintenance specialists continued to be a problem.[31] Because of the relative proximity to the battle area, it was difficult to contract for DS maintenance. However, by increasing contractor support operations in the secure areas, it was possible to free some military maintenance support units for service in the hostile areas.

(18) Sufficient Army aircraft maintenance units arrived in-country to balance out the military/civilian work force and maintain the aircraft fleet at an acceptable operationally ready (OR) level. DS and GS aircraft units at this time numbered 11 and 5, respectively. Contractor personnel were assigned to these units in-country depending upon the units mission and workload. It was estimated that to replace all contractor personnel with military personnel would require 16 additional aircraft direct support companies.[32] Neither these companies nor their equipment and the experienced personnel to fill them were available in the active Army. The decision was that contract maintenance would continue at its present level as a necessary augmentation to the military effort.

(19) In January 1968 the Secretary of Defense requested that the Army conduct a study of maintenance operations in Vietnam.[33] The Secretary's Memorandum requested the Army to:

(a) Analyze the possibilities for increasing the productivity of maintenance units in Vietnam.

(b) Evaluate USARV maintenance requirements and capabilities and examine alternate ways of unit organization in order to minimize support personnel.

(c) Analyze the degree to which general support maintenance should be performed to Vietnam versus use of offshore bases.

(20) The team which conducted a survey of the Army maintenance effort in Vietnam consisted of representatives from the Deputy Chief of Staff for Logistics and the Assistant Chief of Staff, Force Development, as well as the major Army commands: Army Materiel Command; Combat Developments Command; U.S. Army, Pacific; U.S. Army, Vietnam; and the First and Second Logistical Commands. The team report which was completed in August 1968 developed the following findings.

[30] U.S. Army, Pacific, Annual Historical Summary, Part II, Southeast Asia, 1 January 1967 - 31 December 1967.

[31] U.S. Continental Army Command USCONARC/USAR STRIKE Annual Historical Summary, 1 July 1966 - 30 June 1967.

[32] Department of the Army, Deputy Chief of Staff for Logistics, Memorandum, subject: Contractual Services for Aircraft Maintenance in Vietnam, 27 August 1969.

[33] Department of the Army, Deputy Chief of Staff for Logistics, Annual Historical Summary, 1 July 1967 to 30 June 1968.

(a) Maintenance of Ground Equipment

1. An in-country shortfall existed at both the DS and GS levels of maintenance. To satisfy these maintenance requirements, 1,234 additional skilled military repairmen were required, by special skill area. To offset the DS shortfall, which was considered critical, approximately 38.4 percent of the GS capability had been diverted to DS level tasks.

2. The existing maintenance system was responsive because of its utilization of Okinawa and Taiwan maintenance facilities, which precluded the necessity for new in-country facilities. Proposed modifications to TOE in this time frame would have realigned the DS/GS maintenance capability, thereby providing additional DS capability while reducing the GS capability. The resultant GS in-country capability, which was in most cases then exceeding the theater operational readiness standards, would have performed approximately 48.5 percent of the maintenance requirement organically, with the remaining 51.5 percent accomplished offshore (considered optimum for responsive GS maintenance).

3. A quantitative imbalance existed in authorized versus on-hand skills. Authorized skills that were not considered critical were overstrength, and authorized skills that were critical were understrength.

(b) Maintenance of Aircraft

1. The mix and number of DS and GS aircraft maintenance units operating in-country had stabilized and were considered adequate to sustain the desired aircraft availability standards. Supply support for aircraft maintenance had improved markedly with the inception of the Red Ball Express system. As the system matured throughout 1966, the overall NORS rate began to decline to the acceptable Department of the Army standard of 7 percent. By FY 67 the rate had stabilized at about 8 percent and by June of FY 69 had reached a low of less than 4 percent.

2. Aircraft in the hands of using units were being maintained in an outstanding manner. In 1969, with all programmed maintenance units in-country, the operational readiness rates had stabilized at an acceptable level for most categories of equipment. The effects of the increased maintenance capability coupled with Red Ball Express, standardization, and other actions were evidenced in increasing OR rates and the small number of days that equipment was not available to the operator. Tables 5 and 6 show the small percentage of equipment, Not Operationally Ready Maintenance and Not Operationally Ready Supply (NORM/NORS), not available as of 30 September 1969. Table 7 depicts the increasing operational ready rates for 1966 through 1968.

b. Offshore

(1) Intermediate Maintenance. During 1966 and 1967, maintenance units were deployed to Okinawa as a part of the 2nd Logistical Command, which was charged with the support of island forces and offshore general support for Vietnam. The general support workload was primarily for tactical wheeled vehicles, generators, materials handling equipment, and electronic communications items and amounted to 50 percent of the Vietnam requirement. This level of effort was maintained through 1969.

(2) Depot Maintenance

(a) In 1965 Army overseas depot level maintenance existed on a limited basis in Germany and Japan. Depot maintenance activities were manned principally by local nationals, with few spaces authorized for officers and NCOs. The only Army depot level facility in the Pacific was located at U.S. Army Depot Command, Sagami, Japan. Depot capability in Japan consisted of a work force of 504 local nationals devoted to maintenance of Military Assistance

[34] Ibid.

Program (MAP) equipment, construction equipment, tactical wheeled vehicles, and backup to Eighth Army combat vehicles and tactical communications electronics equipment.[35] By the end of FY 66, depot maintenance manning in Japan had been reduced to 463 local nationals, since the military assistance programs had been reduced and the combat vehicles program for the Eighth Army was small. Out-of-country overhaul of marine craft was a responsibility of the 2nd Logistical Command and was performed on Okinawa or under contract in commercial shipyards throughout the Pacific. At the end of 1966 a total of 160 personnel were assigned to the marine craft maintenance function in Okinawa.[36]

TABLE 5

U.S. ARMY, PACIFIC—EQUIPMENT NONAVAILABILITY
(30 SEPTEMBER 1969)

Subordinate Command	Reportable Items On-Hand Qty	Not Operationally Ready FY 70 1/Qtr
USARV	88,492	7,964
USARYIS	2,384	310
USAEIGHT	21,947	1,975
USARJ	286	29
USARSUPTHAI	2,780	861
USARHAW	1,608	96
Total	117,497	10,575

Source: U.S. Army, United States Army, Pacific, Letter, GPLO-MO, Maj. Gen. Durrenberger to Lt. Gen. Hurlbut, Maintenance Information on Vietnam 1968-1969, 30 December 1969.

TABLE 6

U.S. ARMY, VIETNAM—DAYS EQUIPMENT NOT AVAILABLE
(30 SEPTEMBER 1969)

		FY 69				FY 70	
		3rd Qtr		4th Qtr		1st Qtr	
Commodity	Standard	NORS	NORM	NORS	NORM	NORS	NORM
Artillery	7	3	3	3	2	3	2
Combat Vehicles	8	5	4	5	4	6	4
Tactical and Support Vehicles	7	6	3	6	3	6	3
Electronic and Communications Equipment	7	3	2	2	2	2	2
Special Purpose Equipment	25	9	7	9	6	8	6
Aircraft, Rotary Wing	33	7	18	7	16	6	15
Aircraft, Fixed Wing	28	5	10	5	14	5	12

Source: U.S. Army, United States Army Pacific, Letter, GPLO-MO, Maj. Gen. Durrenberger to Lt. Gen. Hurlbut, Maintenance Information on Vietnam 1968-1969, 30 December 1969.

[35] Department of the Army, Worldwide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions, 1965.

[36] Department of the Army Worldwide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions, 1966, -67, -68, -69.

TABLE 7

U.S. ARMY, VIETNAM—OPERATIONALLY READY (OR) RATES

Commodity	FY 66	FY 67	FY 68
Combat Vehicles	*	90	91
Tactical & Support Vehicles	*	*	93
Artillery	92	93	98
Materials Handling Equipment	72	66	83.7
Communications & ADP	91	94	97
Construction	70	72	83
Electric Power Generating			89.5**
Aircraft	66	72	74

*Data not available.
**Electrical power generation equipment added in FY 68 because of criticality.

Source: U.S. Army, Equipment Distribution and Condition Report, 1966-68.

(b) As equipment density and usage in Vietnam increased, it was essential that overhaul capabilities be established in the Pacific to provide responsive support and eliminate the lengthy overhaul pipeline. With the development in 1967 of closed loop support for armored personnel carriers in Vietnam, the Japan depot capabilities were reviewed and plans were made to expand Sagami capacity to cover the requirements of the Eighth Army, USARV, and the Republic of Vietnam Army. Production schedules were increased and a maximum effort was exerted to recruit additional personnel. By the end of FY 67, depot strength in Japan was 615 personnel.[37]

(c) Okinawa continued the marine craft maintenance program, with an end strength of 210 personnel devoted to the mission.[38] In 1968 USARV overhaul requirements continued to increase with greater requirements placed on both Japan and Okinawa. Problems with multifuel engines had necessitated establishment of overhaul and modification programs on Okinawa. The 2nd Logistical Command explored the capability on Taiwan and Okinawa for contract support of generators, materials handling equipment, construction equipment, and tactical wheeled vehicles. Combat vehicle programs for Vietnam were expanded and Eighth Army overhaul programs were reduced to provide the required capacity. Marine craft maintenance programs were being accomplished in Okinawa, where maintenance strengths had reached 1,381 personnel in support of overhaul programs for automotive, construction, electronics-communication, general equipment, and marine craft. Japan depot strength in support of the combat vehicle program had been expanded to 825 personnel.

(d) In 1969, overhaul in the Pacific reached its highest cost level of $35 million.[39] Production of combat vehicles in Japan was increased to 100 personnel carriers and 12 tanks per month; Taiwan capabilities were expanded for wheeled vehicles, MHE, and construction equipment, and initiated for combat vehicles; and Okinawa continued operations at maximum capacity on its assigned programs. Marine craft maintenance contracting functions were assumed

[37] Ibid.
[38] Ibid.
[39] U.S. Army, Pacific, Letter, GPLO-MO, Maintenance Information in the Vietnam Era 1968-69, 30 December 1969.

from the Navy while the use of all existing commercial facilities continued. Depot maintenance of Army aircraft was limited to CONUS throughout the period. By the end of FY 69, the following offshore depot maintenance personnel strengths had been reached.[40]

	Military	DA Civilian	Indigenous
Okinawa	714	122	933
Japan	30	28	1063

c. Continental United States

(1) During the period leading up to the large-scale buildup for Vietnam in 1965, the Army had been bound by an austere fiscal policy in much the same way as the other Services. The policy adopted in CONUS to trim budget expenditures resulted in the decision to eliminate those military organizations not considered necessary for the support of CONUS based tactical forces. The maintenance of a large military organization in a period when there was no actual "hot war" requiring such a large force was looked upon with disfavor. It was felt that military forces could be withdrawn and many of the vacated positions filled with civilians at the post, camp, and station support level. DOD Directive 1100.4 was published (1954) which promulgated the use of civilians "in positions which do not require military incumbents for reason of law, training, security, discipline, rotation or combat readiness and which do not require a military background for successful performance of the duties involved." Many of the supporting CONUS intermediate and depot level maintenance positions fell into this category.

(2) The statement that civilians might be used in lieu of military personnel was another paragraph in the directive which had an added impact on the reduction of active duty maintenance units. The paragraph stated that "the highest practicable proportion of operating Forces to total Forces will be maintained. Within the operating Forces emphasis will be placed on reducing support type operations." Consequently, many units and individual positions were abolished; these were the types of military capability that became sorely needed in 1965 and 1966.

(3) Force planning during this time, to include specific force planning in support of a Vietnam contingency, was based on the assumption that the Reserve components would be mobilized in an operation of such magnitude. Because of stringent active Army strength ceilings, a great number of logistic units that were amenable to civilian skills, and which were not required in the highly civilianized peacetime logistics base, were structured in the Reserve components. With the decision not to call up the Reserves, it became necessary to activate, equip, train, and deploy new Army intermediate maintenance units.

(4) The increase in deployments to SE Asia during FY 66 caused a further marked deterioration of the maintenance capability of USCONARC. This problem arose because a major portion of the command's TOE maintenance units were deployed to SE Asia without Army authorization of a concurrent increase in the fixed field (non-TOE) DS and GS activities. At the beginning of the fiscal year, a total of 94 separate companies performing maintenance missions were assigned to CONARC. By 30 June 1966, 37 of these units had already been deployed to Vietnam and 6 additional companies were under orders to be deployed during the early portion of FY 67. In addition to company-size units, a number of maintenance platoons, detachments, and teams were provided by drawing on the remaining maintenance companies.

(5) USCONARC lost 8 out of 14 Ordnance direct automotive support companies and 3 out of 13 Ordnance direct support companies. In the face of existing problems in vehicle maintenance, a loss of this magnitude had a critical impact on the support of CONUS combat forces. Deployments also reduced significantly the MOS skills available for maintenance support of materials handling and other Quartermaster equipment, signal, avionics, and aircraft.

[40] Department of the Army, Worldwide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions, 1966-69.

(6) Although 49 maintenance companies remained uncommitted in USCONARC at the end of the fiscal year, their maintenance capabilities had been drastically reduced by the drawdown of critical skills, tool sets, and test equipment which was necessary to equip and man the deploying units to their prescribed readiness conditions. New TOE maintenance units had been activated during FY 66, but these were scheduled for deployment to SE Asia in accordance with the Army Buildup Plan.[41] The Army Buildup Plan and the establishment of the Selected Reserve Force imposed additional maintenance workloads on the already overburdened CONARC maintenance capability. The maintenance units included in these programs were not able to increase their capability because of the long lead time required to train hard skill military specialists and procure essential maintenance equipment.

(7) The reorganization of the Technical Services under the COSTAR configuration, initiated in April 1966, served to further aggravate this problem. A reorganization of such magnitude involved a period of unavoidable turbulence inherent in realigning support missions, transferring personnel and equipment, and accomplishing that unit training which was required to develop a cohesive composite support posture.

(8) As a result of these conditions, maintenance backlogs developed at many CONARC installations. The shortfall in maintenance activity was met through temporary civilian hire and heavy reliance on overtime work at the fixed field maintenance shops. While the use of overtime work proved effective on a short-term basis, the prolonged use of this expedient could be expected to impair both efficiency and morale with a resultant continued degradation of the workload.

(9) At the end of FY 66, it was the consensus of CONARC that the provision of minimal maintenance support for both the Army Buildup Plan and the Selected Reserve Force would depend on the authorization of additional personnel spaces and funds to increase the commands fixed field maintenance capability, as well as the provision of additional technical assistance in all commodity areas.[42]

(10) The implementation of COSTAR which required organizational and system changes was of concern to the Department of the Army Board of Inquiry in 1965, particularly since no prior testing or field analysis of these changes had been made. As such the Army Maintenance Board was directed in September 1966 to conduct a comprehensive evaluation of the maintenance and supply system and support operations worldwide, as implemented under COSTAR. The evaluation was accomplished during the period from September 66 to June 68 and covered operations in Seventh and Eighth Army support commands. Findings applicable to the maintenance function indicated the following:

(a) Technical Assistance. The COSTAR doctrine envisions technical assistance visits on a scheduled basis. The lack of depth, however, in MOS skills provided in COSTAR II TOE for direct support maintenance units restricted planned and scheduled technical assistance visits to supported units.

(b) Repair Parts Supply. The number of supply personnel authorized in the supply section of the DS maintenance companies was inadequate to perform the repair parts and supply parts supply functions in support of nondivisional units of a field army. The MHE, packing and crating tools, electronic accounting machines, and automatic data processing equipment, except for keypunch machines, were not authorized by TOE of the headquarters and main support and light maintenance companies.

(c) Direct Support Maintenance. The COSTAR II TOE for DS maintenance companies do not provide the required number of personnel or technical skills to perform maintenance on all equipments of field army units. Functional areas of liaison and control of reparable items are not identified in COSTAR TOE of maintenance units. Personnel to perform the

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[41] U.S. Continental Army Command, The Role of US CONARC in the Army Buildup, FY 1966.
[42] Ibid.

duties of toolroom keeping, maintenance of technical libraries, and the operation of shop supply are not designated in the COSTAR DS maintenance unit TOE.[43]

(11) The findings as a result of a field evaluation, though of great value, were of little help in Vietnam as maintenance units had been reorganized to the COSTAR concept in the combat zone beginning in August 1966.

(12) Training and equipping of the maintenance units was a slow process owing to equipment shortages and the lack of qualified maintenance personnel. During the activations, many units were unable to practice the maintenance function they would perform in the combat theater because most of the intermediate maintenance at the post, camp, or station was performed by civilian-manned field maintenance shops. As a result, maintenance units arrived in the combat zone with little or no experience on the equipment they would be required to support.

(13) In 1966 at a Honolulu conference it became apparent that there would be a substantial shortfall in logistic support units and capabilities required to support United States and Free World forces being deployed to South Vietnam. The major shortfalls were of grave concern to the Military Assistance Command, Vietnam (MACV), because of their potential negative impact on the capability to support planned force deployments and tactical operations.

(14) The two most serious shortfalls in unit availability were in light maintenance company and the division maintenance support company availability. The Army light maintenance company provided direct support to nondivisional units. The shortfall of three companies at the end of the year equated to the support of 25,000 nondivisional troops. This shortfall resulted in:

(a) Higher deadline rates in nondivisional units.

(b) Evacuation to the next maintenance level of equipment normally repaired at the DS level and returned to the user; and replacement items provided.

The division maintenance support company provides direct backup support to the maintenance battalion organic to the division. The shortfall of these companies at the end of the year would place an increased workload on existing units and on the GS maintenance capability. The shortfalls experienced with the two aforementioned units and in GS units are shown in Table 8.

TABLE 8

UNIT SHORTFALLS
(CY 66)

		In-Ctry	Req. by	Shortfalls		
Units	DS/GS	May	Dec.	2nd Qtr.	3rd Qtr.	4th Qtr.
Hv Equip Maint Co	GS	3	10	2	3	2
Lt Equip Maint Co	DS	3	7	0	4	2
Lt Maint Co	DS	5	11	3	1	3
Maint Spt HHC	DS	6	9	1	2	0
Amph Maint Co	GS	1	2	1	0	0
Div Maint Spt Co	DS	2	6	1	3	3

Source: U.S. Army, Deputy Chief of Staff, Logistics, Briefing, subject: Management Measures To Overcome Logistics Shortfalls, 27 June 1966.

[43] Army Materiel Command, Report of Field Army Support Evaluation (FASE-67), June 1968.

(15) Effective support of U.S. Army, Vietnam, was achieved only at the continued expense of the Strategic Army Force (STRAF) maintenance posture. Although new maintenance units required to reconstitute the STRAF had been activated in adequate numbers and type, their maintenance mission capabilities suffered owing to shortages of qualified personnel and equipment.[44] The personnel problem remained serious with respect to experienced technicians and maintenance supervisors and equipment shortages continued to degrade unit readiness, with tools and test equipment for aircraft and electronics maintenance being critically short. The personnel situation was expected to improve as experienced personnel rotated back from Vietnam in increasing numbers, but no solution to the equipment problem was in sight.

(16) CONARC at this time placed strong emphasis on improving the CONUS training base for maintenance units and individuals. This effort included providing mission maintenance work for units and a program of intensified on-the-job training in non-TOE shops and TOE maintenance units for replacement personnel eligible for overseas assignments.[45]

(17) During FY 68, USCONARC continued to support the maintenance effort of Army forces in SE Asia by training and deploying replacement maintenance personnel and maintenance support units. When the number of units deployed leveled off, the emphasis on maintenance training in the CONUS base shifted from quantity to quality. Based on feedback information in operational reports from USARV, coupled with the findings of CONARC Liaison Training Teams dispatched to the theater, maintenance training was intensified in the U.S. Army Training Centers, Army Service Schools, and units. In operator and mechanics training, emphasis was on practical experience. For supervisors and maintenance managers, strong emphasis was placed on improving the skills of officers and noncommissioned officers in materiel readiness reporting.[46]

(18) Army CONUS Depot Maintenance experienced major changes as a result of the Vietnam buildup in size, management, control. At the beginning of the era annual depot programs were funded at $175 million, utilizing an organic work force of 29,000 personnel.

(19) Overhaul programs were developed by the commodity commands based on reparable assets on hand in the CONUS depots. No Army-wide criteria for overhaul had been developed; hence items were retrograded to the depots only when they exceeded the capability of general support maintenance units. Operating under the Inspect and Repair Only as Necessary concept of maintenance, depot asset accumulation was sporadic and random in nature. Item managers were hampered in developing firm overhaul requirements, since no firm basis existed for computing asset availability.

(20) Control of depot maintenance facilities was vested in the Army Materiel Command for CONUS depots and the theater commanders for overseas depots. Theater commanders developed their own overhaul programs based on theater readiness requirements and experiences. In developing programs, overseas theaters planned portions of their program under depot materiel maintenance funding (BP2300), and others under general support funds (BPA9020). Those programs funded under the former program were known to Department of the Army which controlled the funds; however, those under the latter program were not visible at Department of the Army level, since no requirement existed to identify GS level programs. The funding technique used was advantageous to the theater when programs were based on anticipated requirements, since funds could be transferred to other theater functions if assets failed to materialize. Fiscal adjustments on depot materiel maintenance funds were denied this flexibility, except to the Department of the Army.[47]

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[44] U.S. Continental Army Command, The Role of US CONARC in the Army Buildup, FY 67.
[45] U.S. Continental Army Command, US CONARC/USAR STRIKE Annual History Summary, 1 July 1966.
[46] U.S. Continental Army Command, US CONARC/USAR STRIKE Annual Historical Summary, 1 July 1967-30 June 1968.
[47] Department of the Army Regulation 37-100-69, The Army Management Structure (Fiscal Code), 28 December 1967.

(21) Supply support for overhaul programs was coordinated on a rather informal basis; however, there was no special repair parts procurement or stockage to support these programs. Repair parts availability was reviewed prior to program development but unusual demands from the field could, and often did, deplete the stocks to the detriment of the overhaul programs.[48]

(22) Earlier efforts to establish a valid data base for requirements determination proved useful during the era. Equipment authorizations were identified by the major items data agency, and usage and performance factors were established using information available through the Army Equipment Records System. Cyclic overhaul criteria were established for aircraft, combat vehicles, artillery, and other equipment essential to support of SE Asia operations in 1966 and were used in conjunction with combat loss rates to determine actual overhaul requirements on a real-time basis. These factual requirements were used to establish in-theater and CONUS overhaul programs, as well as supporting programs and resupply schedules through a technique called Closed Loop Support. Closed Loop Support (CLS) displayed the total requirement for a particular item stratified to each element of the supply and maintenance pipeline and provided quantitative means for measuring the performance of each element. Visibility for management purposes was immediately available and provided a discipline to the total system which previously had been missing. The CLS system was a key development in ensuring adequate depot maintenance support of Army Forces in SE Asia.[49]

(23) Improvements in performance were facilitated by changes in repair parts support. Significant gains were realized in forecasting support overhaul programs and were specifically identified and reserved for that purpose. Further, depot parts problems were included in monthly progress and performance reports, enabling the Army Materiel Command and Department of the Army to expedite solutions.[50]

(24) As total visibility of worldwide depot maintenance requirements improved and annual funding increased it became essential that total capacity be visible. Improved program control was fostered by the inauguration of semiannual worldwide maintenance conferences at which theater, Army Materiel Command, and Department of the Army representatives reviewed requirements and capabilities, and developed worldwide programs. The transfer of all major programs to depot funding was effected and monthly performance reporting was required from oversea depots. The feasibility of providing centralized program control of worldwide depot maintenance was proven, and the Army Materiel Command was directed to develop the plans and procedures necessary to assume this responsibility effective 1 July 1967. While command and control of overseas depots remained with the theater, program progress and performance review was vested in the Army Materiel Command. Funding continued directly from the Department of the Army.[51]

(25) The impact of Vietnam operations on depot maintenance programs are portrayed in Table 9 and Figures 2 and 3. Annual direct obligations increased threefold during the period, with the major increases occurring in aircraft and combat vehicle overhaul. Significant in the upward trend of expenditures was the increased use of contract maintenance, which expanded from $54 million in FY 65 to $207.8 million in FY 69. Table 10 portrays CONUS Army depots, missions, and strengths.[52]

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[48] Army Materiel Command, Arsenal for the Brave; A History of the AMC, 1962-1968.
[49] U.S. Army, Pacific, Annual Historical Summary, Part II, Southeast Asia, 1 January 1967 - 31 December 1967.
[50] Department of the Army, Deputy Chief of Staff, Logistics, Letter, subject: Schedule and Performance Reporting of Depot Maintenance, July 1968.
[51] Army Materiel Command, Arsenal for the Brave; A History of the AMC, 1962-1968, Chapter XII.
[52] Department of the Army, Worldwide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions, 1966, -67, -68, -69.

TABLE 9

DEPOT MATERIEL MAINTENANCE AND SUPPORT ACTIVITIES
ACTUAL COSTS
(Thousands of Dollars)

Item	FY 65	FY 66	FY 67	FY 68	FY 69	FY 70*
Aircraft	62,120	87,129	123,094	187,284	268,004	298,412
Automotive Equipment	16,689	24,417	33,219	46,797	46,069	41,124
Combat Vehicles	37,004	44,318	56,857	84,275	85,122	80,880
Construction Equipment	3,071	4,016	4,248	9,563	10,224	13,046
Electric Communications Equipment	12,458	9,445	16,812	24,500	30,144	33,285
Missile Systems	15,612	31,695	36,200	61,839	44,711	44,971
Ships	6,464	12,774	14,237	17,949	16,960	10,483
Munitions						7,897
Weapons	6,428	19,727	17,749	17,637	17,013	9,795
Rail	802	3,341	2,001	2,650	1,353	1,510
General Equipment	3,081	5,881	5,850	8,797	14,121	14,211
Commodity Groups	10,413	15,382	16,115	16,465	16,562	14,552
Materiel Support	12,578	36,414	25,106	24,870	14,237	12,388
Maintenance Support Activities	93,450	114,602	133,289	173,522	175,029	163,061
Base Operations	7,873	8,720	11,789	14,341	6,747	6,400
Total (BP 2300)	288,093	417,861	496,566	690,489	791,807	743,433

*Estimated.

Source: Department of the Army, Deputy Chief of Staff, Logistics, BP 2300 Depot Materiel Maintenance and Support Activities, 1 October 1969.

3. CHANGES, PROBLEMS, AND CORRECTIVE ACTION IN MAINTENANCE SUPPORT DURING THE VIETNAM ERA

a. Increase of the Direct Support Maintenance Capability of Aviation Units. Direct support aviation maintenance was provided to the Army aircraft fleet in Vietnam by the methods indicated below.

(1) Airmobile Division. Each operational aviation company was organized along conventional lines. DS maintenance was provided to all aviation elements by the division aircraft maintenance battalion consisting of four aircraft DS maintenance companies. Nondivisional units included decentralized DS maintenance structure established through separate DA detachments collocated and assigned to all aviation companies. Backup DS maintenance was provided by DS companies assigned to the 34th General Support Group (AM&S).

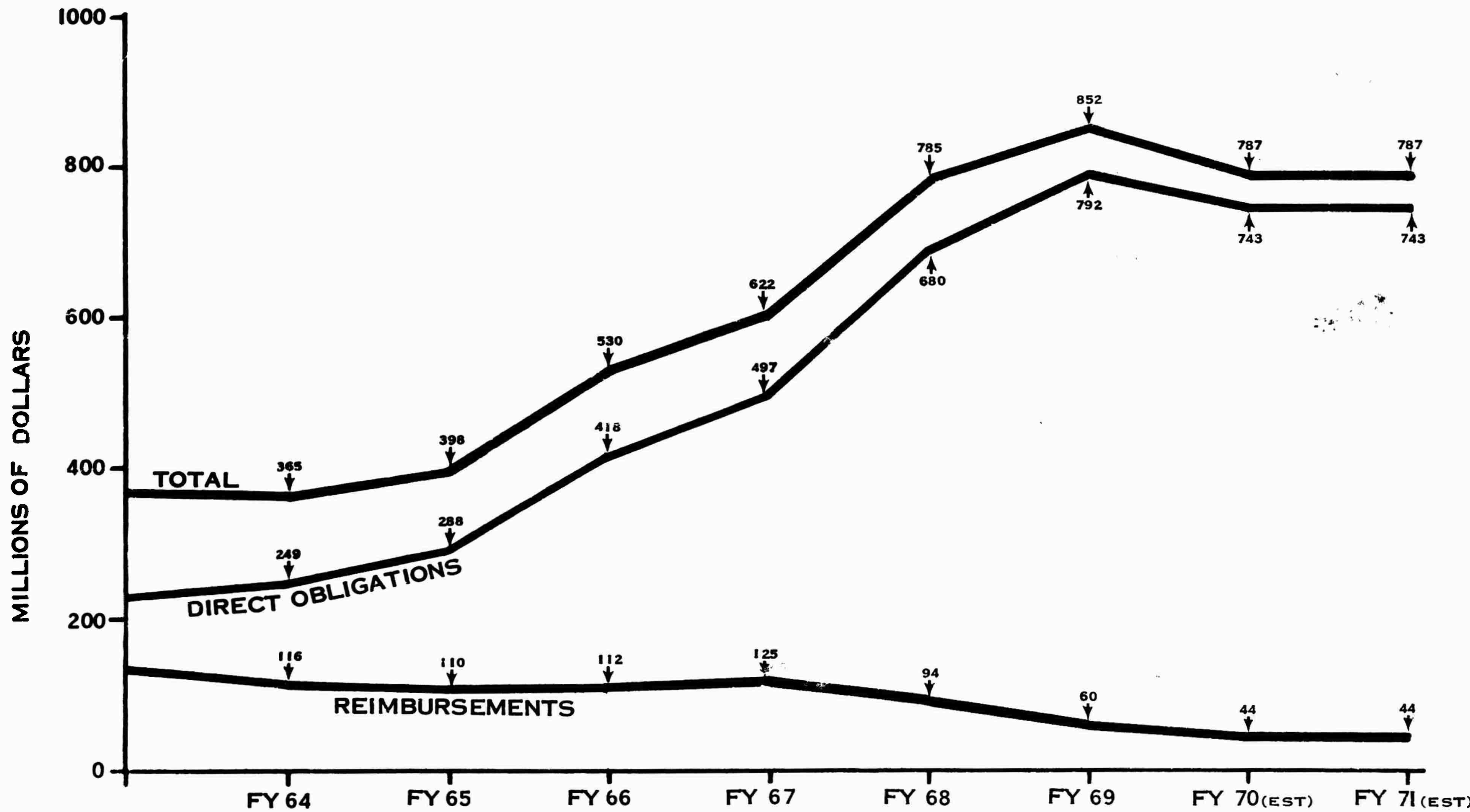

FIGURE 2. BP 2300 DEPOT MATERIEL MAINTENANCE AND SUPPORT ACTIVITIES

Source: Department of the Army, Deputy Chief of Staff, Logistics, BP 2300 Depot Materiel Maintenance and Support Activities, 1 October 1969.

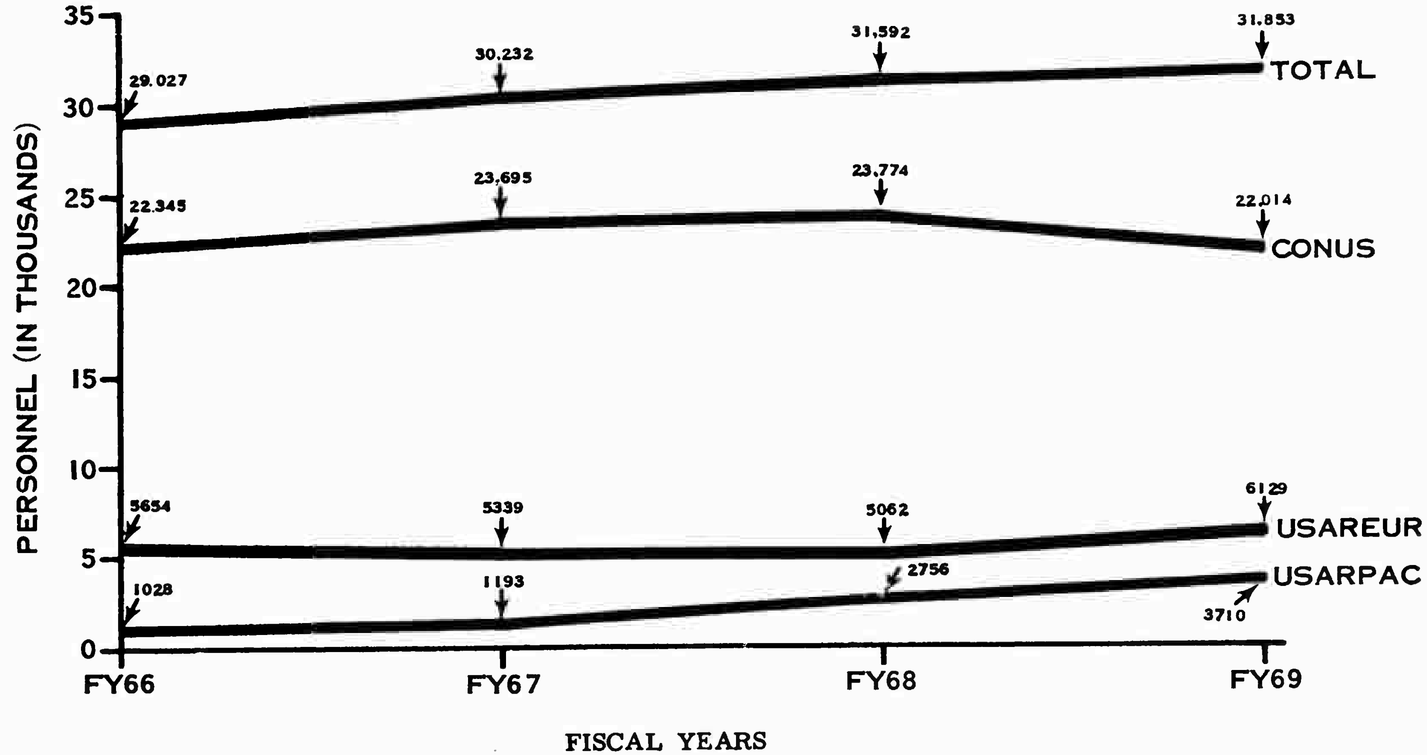

FIGURE 3. ARMY DEPOT MAINTENANCE MANPOWER

Source: Department of the Army, Worldwide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions 1966, -67, -68, and -69.

TABLE 10

LOCATION, MISSION, AND STRENGTH OF CONUS DEPOTS

Name and Location	Mission	Strength 1966 Mil	Strength 1966 Civ	Strength 1969 Mil	Strength 1969 Civ
Anniston Army Depot Anniston, Ala.	Depot Maintenance on Combat Vehicles, Automotive Equipment, and Armament	3	1754	8	1900
Army Aeronautical Depot Maintenance Center, Corpus Christi, Tex.	Depot Maintenance on Aircraft and Avionics	34	2826	18	3658
Floating Aircraft Maintenance Facility (FAMF)	Direct Support and General Support Depot Maintenance on Aircraft Components and Assemblies			637*	
Atlanta Army Depot Forest Park, Ga.	Depot Maintenance on Aircraft, Automotive, Construction, Rail, and General Equipment	10	610	22	700
Charleston Army Depot North Charleston, S.C.	Depot Maintenance on Ships, Rail, and General Equipment	1	131	5	104
Granite City Army Depot Granite City, Ill.	Depot Maintenance on Automotive, Construction, Armament, Rail, General Equipment, and Missile Components	--	308	7	318
Letterkenny Army Depot Chambersburg, Pa.	Depot Maintenance on Automotive Combat Vehicles, Missiles, Armanent, and General Equipment	8	2217	9	1702
Lexington—Blue Grass Army Depot Lexington, Ky.	Depot Maintenance on Electronics and Communications Equipment	8	2156	9	1724
New Cumberland Army Depot New Cumberland, Pa.	Depot Maintenance on Aircraft Construction, and Rail Equipment	25	532	17	766
Pueblo Army Depot Pueblo, Colorado	Depot Maintenance on Automotive Combat Vehicles, Armament and General Equipment	8	1415	8	1364
Red River Army Depot Texarkana, Tex.	Depot Maintenance on Automotive Combat Vehicles, Armament, Rail, and General Equipment	--	2355	8	1786
Sacramento Army Depot Sacrament, Calif.	Depot Maintenance on Electronics and Communications, and General Equipment	--	1127	10	1138
Sharpe Army Depot Lathrop, Calif.	Depot Maintenance on Aircraft and Automotive Equipment, and Combat Vehicle Components	--	839	19	870
Tobyhanna Army Depot Tobyhanna, Pa.	Depot Maintenance on Electronics and Communications, Automotive, Construction, and General Equipment	--	1641	12	1825
USA Support Center Richmond, Va.	Depot Maintenance on Automotive Air Delivery, and General Equipment	7	294	1	138
Tooele Army Depot Tooele, Utah	Depot Maintenance on Automotive Combat Vehicle, Construction, Armament, and General Equipment	2	2239	9	1637
Rock Island Arsenal Rock Island, Ill.	Depot Maintenance on Automotive Combat Vehicles, Armament Equipment	--	--	--	226

*Became operational in Vietnam.

Source: Department of the Army, Worldwide Depot Maintenance Facilities and Maintenance Support Activities, Locations, Personnel and Missions, 30 June 1969.

(2) Infantry Division

(a) Aviation units belonging to the divisions were supported by a DS aviation maintenance company assigned either to the division maintenance battalion or to the division aviation group.

(b) Initially both divisional and nondivisional DS aircraft maintenance units were retained within the functionalized maintenance structure in order to assume positive maintenance management of these assets. Through the extensive aircraft operational experiences encountered in Vietnam it was found that conventional organizational maintenance organizations did not provide the desired level of availability and mission ready aircraft to meet tactical requirements. As a result, various methods of maintenance support were examined in an attempt to increase availability dates. By collocating a DS aircraft maintenance detachment with an aviation operatic i unit, an inc ease in aircraft availability of approximately 10 percent was realized. In Mai h 1968 the Chief of Staff approved the concept of integrating the assigned maintenance detachments into USARV airmobile units.

(c) The major aspect of the integrated system was that both organizational and direct support maintenance became the responsibility of the company commander. Backup DS maintenance units were still used to take care of extensive crash damage repairs, operational readiness float support, and voluminous repair parts storage, receipt and issue requirements. The increased direct support organic maintenance capability for aviation units permitted the unit to satisfy its operational requirements without a loss of assets for extended periods of time or without unacceptable degradation of tactical deployment capability.[53]

b. Floating Aircraft Maintenance Facility

(1) In April 1966 the Army deployed to Vietnam a Floating Aircraft Maintenance Facility (FAMF), the USNS Corpus Christi Bay. The ship was converted from a seaplane tender in 1965 at the Navy Yard, Charleston, S.C. The FAMF concept was designed for use in contingency operations and could provide a limited depot capability for the repair of aircraft components. In addition the ship was equipped to manufacture small machined parts and fittings. The facility was effective for the repair of items which required extensive test equipment operating in a sterile environment. Avionics, instruments, carburetors, fuel controls, and hydraulic pumps were among the principal items that required testing after repair and which were handled more safely onboard ship than in the sand- and dirt-filled shore environment. The mobility which the ship offered also contributed to the effectiveness of aircraft support. The ship could move to different deep water ports as the density of aircraft units shifted throughout the country in conjunction with the changing tactical situation.[54] Table 11 compares the productivity of FAMF in support of aircraft in Vietnam.

(2) The FAMF has been responsible for removing a substantial number of aircraft from a NORS condition as a result of three major lines of activity:

(a) Returning to serviceable condition components that, at any given time, are the cause of NORS among the aircraft which it upports and components which are chronically short.

(b) Issuing parts from its s op stock in direct response to user requests. While this aspect is primarily a fallout of supply for its normal operations, its significance in practice is such that it must be recognized. It is particularly effective in this role in the first days after a move to a new location in suppo t of operations where it acts as a floating "fly-away kit."

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[53] Army Combat Developments Command, Mainten ice Agency Study, Integration of Direct Support Maintenance Detachments, February 1969.

[54] U.S. Army, Vietnam, 34th General Support Grou Review and Analysis of the U.S. Army Logistics Systems in RVN, August 1969.

TABLE 11

FLOATING AIRCRAFT MAINTENANCE FACILITY—
COMPARISON OF PRODUCTIVITY (%) IN SUPPORT OF AIRCRAFT IN VIETNAM

Aircraft	Population*	Dollar Value	No. of Items Inducted	Acquisition Value	Man-Hours Expended	Parts Cost
UH-1	64.0	53.9	69.7	64.2	70.2	78.1
CH-47	7.5	30.1	14.3	32.2	10.9	17.6
CH-54	0.2	1.8	0.2	0.1	0.1	0
OH-23	5.8	1.1	1.5	0.1	0.7	0
OH-13	5.1	1.0	2.0	0.3	1.6	0.7
O-1	9.3	1.2	3.3	0.4	7.4	0.6
OV-1	2.4	8.3	1.7	0.7	0.4	0.1
U-1A	1.1	0.5	1.0	0.1	0.5	0.2
U-6A	2.1	0.7	2.3	1.0	6.1	2.0
U-8	2.1	0.9	2.7	0.3	1.4	0.2
AH-1G	0.4	0.5	1.3	0.6	0.7	0.5

*Average population in first half of FY 68.

Source: American Power Jet Company, Study APJ 506-6, Cost and Effectiveness of FAMF I and FAMF II (ALV), April 1968.

(c) The manufacture and fabrication of parts. This is also in direct response to user request and is not restricted to aircraft support. Parts manufactured under this program have ranged from special sights for M16 rifles (for immediate use on long-range combat patrols) to parts for such diverse end items as automatic data processing and construction equipment. These items have frequently been of a pivotal nature, and their restoration to operational status had an impact beyond the removal of one piece of equipment from deadline status.

(3) Because of its special capability and special maintenance mission, approximately 600 aircraft per year were removed from NORS status by the FAMF's repair of components and their return to the supply system in serviceable condition. The results of the FAMF effort, a gain in aircraft availability of approximately 7,300 aircraft days per year, demonstrated that the performance of the FAMF was an asset to the aviation maintenance function.

c. Contract Maintenance Support

(1) In the Vietnam conflict, the Army used contract maintenance support extensively in the combat zone. The situation that precipitated the extensive use of contract maintenance support was the inadequacy of the CONUS base to provide sufficient maintenance units or qualified personnel in the time frame required. Also, the controlled military manpower ceiling did not affect the manpower obtained through contracts.

(2) The Army in Vietnam used contract maintenance for the repair of wheeled and tracked vehicles, artillery pieces, heavy engineer equipment, avionics items, marine craft,

aircraft and end items and components. Repair in some cases was accomplished under contract from the organizational through the depot maintenance level.[55]

(3) At Cam Ranh Bay the Vinnell Corporation operated four organizational and intermediate level maintenance shops for the 1st Logistical Command, 69th Maintenance Battalion. The facilities and equipment were valued at $6 million. The maintenance portion of the Vinnell contract totaled $10.8 million and encompassed marine maintenance, operation of the organizational and intermediate maintenance shops, care and preservation of materiel, track and suspension repair, and component reconditioning. The unexpected use of extensive contract maintenance gave rise to several problems which might have been precluded had the requirement and associated plans been developed in advance. Vinnell Corporation, in its report to the JLRB in June 1969, cited the following weaknesses in the logistic system:

(a) Inadequate supply of Government-furnished property and equipment.

(b) Inadequate support by Army on contractor forecasted requirements.

(c) Inadequate storage facilities in initial stages of operations.

(d) Inability of government officials to react to the requirement for safeguarding materials and supplies.[56]

(4) The advent of the large-scale buildup of the Army aviation program in USARV in FY 66 necessitated reliance on contractor maintenance personnel to augment the capabilities of Army aviation maintenance units. The 34th Army General Support Group supervised three contracts to United States companies to provide on-site organizational and intermediate level maintenance. From FY 66 through FY 70, the contractors provided an average of 1,366 United States civilians at an average total cost of $19.1 million. Averaged out, Dynaelectron furnished 713 personnel at an average annual cost of $9.1 million, Lockheed had 197 personnel at an average annual cost of $3.1 million, and Lear Siegler had 662 personnel at an average annual cost of $10.1 million.[57]

(5) Having no in-country organic depot capability in Vietnam for the accomplishment of watercraft overhauls, the Army developed a limited contract support capability at Cam Ranh Bay with the Vinnell Corporation. Over and above Vinnell's capacity, Army craft were towed or shipped to commercial shipyards in Taiwan, the Philippines, or Singapore for performance of depot level maintenance and repairs. Although the Navy contracted for this work, the Army 2nd Logistical Command was responsible for all planning scheduling, logistic support, monitoring, and reporting under the Navy contracts.

(6) Table 12 depicts the Army and Navy SE Asia watercraft population. The overhauls programmed for both Services in FY 69 are shown in Table 13.

(7) Contractor personnel performed an invaluable service in at least two areas, where a lack of military repair experience and talent existed: intermediate and depot level battle-damaged airframe repair and intermediate vehicle and component repair. Without contract maintenance support it would have been difficult for the Army to sustain itself in Vietnam.[58]

(8) Plans for contract logistic support to offset a shortage in the military capability have normally been considered impractical, since adequate backup maintenance units have

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[55] Department of Defense, Office of the Assistant Secretary of Defense (Installations and Logistics), Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

[56] Vinnell Corporation, Letter to General Besson, subject: Briefing Information on Vietnam Projects, 4 June 1969.

[57] Department of the Army, Deputy Chief of Staff for Logistics, Memorandum, subject: Contractual Services for Aircraft Maintenance in Vietnam, 27 August 1969.

[58] Department of Defense, Office of the Assistant Secretary of Defense (I&L), Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

always been structured in the Reserves. In a situation such as Vietnam where the reserve maintenance units were not activated and where military force ceilings were prevalent, contractor support became the main method of increasing the Army maintenance capability. To preclude a shortfall in the Army maintenance capability in future conflicts, plans should be formulated which consider the use of contract maintenance support when sufficient active Army maintenance units are not available and reserve maintenance unit activation is not contemplated.

TABLE 12

PACIFIC OCEAN AREA (POA)
WATERCRAFT POPULATION—FY 69

Area	Army			Navy		
	Craft*	Boats	Total	Craft*	Boats	Total
RVN	603	704	1,307	248	603	851
POA less RVN	80	131	211	476	373	849
TOTAL	683	835	1,518	724	976	1,700

*LCM-6 and LCM-8 included as craft.

TABLE 13

RVN OFFSHORE WATERCRAFT OVERHAUL PROGRAM

Fiscal Year	Army		Navy	
	Number of Out-of-Country Overhauls*	Estimated Cost (Millions of Dollars)	Number of Out-of-Country Overhauls*	Estimated Cost (Millions of Dollars)
1967	64	2.6	--	--
1968	171	5.5	28	1.3
1969	196	7.0	76	4.5

*Includes unscheduled repairs.

Source: Department of Defense, Office of the Assistant Secretary of Defense (I&L), Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

d. Closed Loop Support

(1) Maintaining a balance between equipment requirements and availability required careful planning and programming. In 1966, as a means of enhancing this balance, USARPAC initiated an intensive management concept to control the flow of critical items and selected components to Vietnam. The concept was called Closed Loop Support (CLS) and provided "push" shipments based on programmed monthly requirements rather than requisitions. Under this concept the functions of supply, maintenance, and retrograde were integrated into the control system to ensure that critical items were directed to specific customers at the appropriate time and that unserviceables were retrograded to designated repair and overhaul agencies. Although the Red Ball Express program in Vietnam and the 999 System in other areas were still functioning, they proved inadequate to cope fully with the huge supply and maintenance problem. CLS

relies on fast, efficient transportation to move serviceable and unserviceable assets between Vietnam and offshore bases.[59]

(2) In early 1967, working committees were formed to develop data required to intensively manage selected end items, components, and repair parts. The concept, when fully implemented, was expected to make available to project manager teams complete information regarding density, status of maintenance, retrograde program, and supply status within the theater and in CONUS. In April 1967, The Department of the Army formally complemented the CLS program in USARPAC in assigning project codes to M48A3 tanks, the M113 family of armored personnel carriers, and other items. The system was expanded to include 81 major items and 68 secondary items and monitored the movement of both serviceable and unserviceable end items, assemblies and components to and from Army units to ensure the desired level of operational readiness.

(3) The foundation of the CLS is the control of reparables and their continuous return to the overhaul facilities. In 1965, the ability of National Inventory Control Points (NICPs) to forecast the specific quantity of reparables being returned to an overhaul facility was sporadic. After the initiation of the CLS, the item managers' ability to forecast returns increased. An example of the encouraging results of the CLS program, shown in Table 14, is the return of reparables managed by the U.S. Army Weapons Command before and after the initiation of CLS system. During FY 70, return of reparable unserviceables from USARV exceeded the programmed quantity. Specifically, 28,406 items were returned against a programmed quantity of 28,315 for a 100.3 program effectiveness. The program was exceeded primarily due to greater command emphasis on retrograding the on-hand unserviceables coupled with an increased rate of return of items to users, thereby releasing marginally effective equipment for overhaul.[60]

TABLE 14

EXAMPLE OF CLOSED LOOP SUPPORT PROGRAM RESULTS

Item	Return of Reparables Prior to CLS Jul 65 – Oct 67	Return of Reparables After CLS Nov 67 - Aug 69
M107 Vehicle (Mount Assy)	66%	98%
M101A1 Howitzers (Recoils)	78%	98%
M114A1 Howitzers (Recoils)	80%	96%
M102 Howitzers (Recoils)	35%	80%

Source: Army Materiel Command, Letter, subject: Closed Loop Support, 28 January 1970.

e. Repair Cycle Float

(1) The value of maintenance float at the intermediate level of maintenance had been proven in peacetime and was even more of an asset during the Vietnam era. As constituted, the float was intended to provide a means of maintaining an operationally ready item of equipment in the hands of troops during those periods when their equipment was in intermediate maintenance. In Vietnam the float proved particularly valuable as a means of replacing damaged but reparable equipment in using units, thus maintaining their combat effectiveness.

(2) The development of cyclic overhaul criteria and the increased equipment usage rates in Vietnam generated a requirement to establish systematic procedures for removing

[59] U.S. Army, Pacific, Annual Historical Summary Part II Southeast Asia, 1 January 1967-31 December 1967.
[60] Department of the Army Report, Closed Loop Support, Monthly Report RCS CSGLD-1423, January 1970.

equipment from using units, returning the equipment to a depot for overhaul and subsequently reissuing it for field use. To accomplish these programs it was essential that serviceable assets be available for issue to units to replace equipment turned in for overhaul. Use of the existing maintenance float for this purpose negated the value and purpose of the float and was found to be impractical.

(3) With the development of detailed retrograde, overhaul, and resupply schedules under CLS and other intensive management programs, it was possible to quantify, by item, the requirements for assets to support overhaul programs. A methodology was developed and detailed procedures established for identifying the requirements quantitatively and including them in annual materiel programs. To identify the assets, and separate them from the traditional maintenance float, they were designated as a repair cycle float. The existing maintenance float assets were appropriately redesignated "operational readiness float." The two, when considered in total, were considered the total maintenance float requirement.

(4) The value of the increased readiness rates and improved program performance justify the repair cycle float assets.[61]

f. Watercraft

(1) Support for deployed watercraft became a major concern in 1966 as a result of the rapid buildup and high usage rate in Vietnam. Organic intermediate capability was nonexistent, crews were not sufficiently experienced to provide onboard maintenance, and shorebased depot facilities were extremely limited. Intermediate maintenance capabilities were developed in-country through contracting and while this approach was contrary to policy at the time, it provided the required timely capability with a minimum of military personnel.

(2) The intermediate capability was subsequently expanded to also provide depot level support for selected craft. Navy and commercial facilities throughout the Pacific area were surveyed to develop an adequate depot maintenance capacity. Existing facilities at Okinawa were used to maximum capacity. Navy resources in the Philippines and commercial yards in Singapore, Philippines, Taiwan, and Japan were also utilized. Marine maintenance activities were established in Vietnam and Okinawa to provide necessary management and ship surveyor personnel to effectively control the program. Contracting services were obtained from Navy activities through interservice support agreements with responsibility for specifications, supplies, and technical supervision retained by the Army.[62] Interservice support agreements were finally terminated when Army elements assumed all contracting functions in FY 70.

(3) Supply support for watercraft proved to be a major constraint in the early stages of the Vietnam conflict. Inactivity of the Army fleet had resulted in a low priority with respect to fiscal competition the low priority caused cataloging, procurement, and stockage sources to become dormant. With the sudden upsurge in requirements, supply managers were faced with the task of procuring out-of-stock parts with incomplete technical data from sources which had, in many cases, converted to other products. Through intensive management efforts a direct delivery supply system was established, procurement and deliveries were expedited, and the supply posture rapidly improved.

(4) Work specifications based on initial inspections conducted prior to the delivery of the craft to repair facilities was inadequate and costly. Craft were frequently retained in-country beyond the scheduled overhaul date because of operational requirements and were also cannibalized prior to release to overhaul facilities in order to maintain operating fleet readiness. These actions diluted the effectiveness of inspections, delayed contractor work, and required frequent changes to such specifications after initiation of overhaul.

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[61] Department of the Army, Army Regulation 750-19, Maintenance of Supplies and Equipment, Maintenance Float Support of Army Materiel, 25 March 1970.

[62] U.S. Army, Pacific, Annual Historical Summary: Part I, General Summary, 1 July 1965, 31 December 1966.

(5) Establishment of a direct delivery supply system, intensive management by the Army Materiel Command, consolidation of all contracting functions under control of Okinawa, and assignment of qualified ship surveyors alleviated the support problems encountered during 1966-67. By 1969 the marine craft maintenance program was effective and on schedule.

g. Multifuel Engines

(1) A critical problem encountered during the Vietnam era was the unsatisfactory performance of the new family of multifuel engines. Although the problem was shared world-wide, its existence in Vietnam was particularly significant because of the concentration of this type of equipment in that locale. The deadline rate for trucks equipped with multifuel engines was continuously above the established standard. The principal cause of the high deadline rate was the engine, whose head gaskets, valves, and fuel injection components consistently failed. Several of the engine failures were attributed to deficiencies in operator and organizational maintenance. In an effort to improve the condition, maintenance teams were sent to South Vietnam to apply modifications to vehicles and instruct maintenance personnel at the organizational direct support and general support levels of maintenance.

(2) In July 1966, the standard 5-ton multifuel engine replacement rate of 6 per 100 vehicles per year became invalid and a new rate of one engine per vehicle per year was established. Contributory causes of the engine failure were attributed to conditions under which the vehicles operated—dusty atmosphere, broken road surfaces, rough cross-country terrain, steep grades, and high monthly mileage (an average of 2,000 miles per month in transportation line haul units.)[63] The majority of the early engine failures were caused by cracked blocks, cracked heads, blown head gaskets, broken valve stems, and broken connecting rods.

(3) In January 1967 more than 300 5-ton trucks were deadlined in Vietnam because of inoperative engines with a similar condition existing for 2-1/2-ton trucks. A study conducted at that time indicated that many failures occurred between 9,000 and 10,000 miles and that the units hardest hit were line haul units whose engines were subjected to continuous use. The prospect for improvement at this point was negligible because of the lack of repair parts and overhaul capability. A similar condition existed in Thailand where a lack of engine replacements and repair parts accounted for a high deadline rate. The engines were returned to CONUS for overhaul, and Red River Depot was designated as a control point for overhaul and cannibalization of all unserviceable multifuel engines.

(4) By the summer of 1967 the situation had deteriorated to the point where an airlift program was put into effect in an attempt to alleviate the shortage of engines and repair parts. The Red Ball Express and other methods of expediting supplies had not solved the problem. The seriousness of the situation led to a multifuel engine conference on 28 August 1967. A selected group of tactical wheeled vehicles and related major assemblies were reviewed to determine the need for management of the items under the CLS concept in SE Asia.

(5) The problems addressed by the conferees were focused on the multifuel engine problem. At the time of the conference, many Red Ball requisitions remained open, forecasted input from production was inadequate to meet requirements for engines, and, because of a lack of repair parts and/or engine replacement assemblies, an increasing deadline rate was expected within the theater. Major problems existed in storage and maintenance—there were about 1,200 vehicles awaiting parts and maintenance schedules exceeded the maintenance capabilities in theater. It became apparent that unless an early solution was provided for the multifuel engine malfunction, additional replacement vehicles would be required to sustain the operational readiness posture of the theater.

(6) The conference resulted in several recommendations being made to the Department of the Army. The most significant of the recommendations was that three multifuel engines,

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[63] U.S. Army Pacific, Annual Historical Summary: Part II, Southeast Asia, 1 January 1967-31 December 1967.

LD 427, LD 465, and LDS 465, be placed under CLS management because of the inability of units in the field to cope with maintenance problems. A further recommendation was made that evacuation to CONUS of vehicles that could not be supported with multifuel repair parts or replacement engine assemblies be authorized. DA approved the recommendations and directed that necessary retrograde, overhaul, and shipping operations be initiated immediately.

(7) Although the conference had focused attention on the supply support status and premature failure of the engine, a significant intangible that remained unsolved was proper operation of the vehicle and user maintenance. Because of the characteristic difference of the multifuel engine from the standard internal combustion engine, periodic maintenance and specific mandatory operational procedures that differed sharply from procedures used with other vehicles required closer attention.

(8) By the end of October the situation had deteriorated further. The shortage of multifuel engines had resulted in excessively high deadline rates for the 2-1/2- and 5-ton truck fleet. Because a large percentage of the production line was consumed in end item assembly, the major source of obtaining replacement engines became the overhaul facilities. Intensive efforts were made to improve engine performance by stressing proper operation, improving maintenance procedures, and by an examination of the engine itself. Improved driver and mechanic performance provided a slight improvement but the basic design problems inherent in the engine defied a "quick-fix."[64] Red Ball Express, airlift of parts and engines, management under closed loop, and intensive technical assistance and training were used in an attempt to enable the field to live with the problem until a replacement engine could be distributed.

(9) Concurrent with efforts to assist the field, AMC embarked on a series of studies aimed at applying commercial experience to a solution of the problem. Analytic studies of power requirements, evaluation of commercial line haul maintenance experience, and several cost-effectiveness studies resulted in the decision to utilize any one of several commercial diesel engines to power all 5-ton vehicles procured after FY 68. The FY 68 procurement of 5-ton vehicles utilized the Mack ENDT 673 engine. The FY 69-71 multiyear procurement utilizes the Cummins NH 250 engine. Existing assets of multifuel engines will be attrited from the Army over a year period. The commercial diesel engines were expected to increase the median mileage previously experienced and reduce the high deadline rates.[65] The unsatisfactory performance of the engine indicates that, despite years of testing effort, the engine did not possess the ruggedness and tolerance to withstand the abuse essential to successful field operation.

h. Equipment Standardization

(1) "At the beginning of the Vietnam era the Army was faced with one of the most perplexing logistics problems in its long history. While some 145 deep draft ships were awaiting discharge at Vietnam ports, much of the equipment ashore that could be used to hasten the unloading of cargo from these vessels was deadlined for the lack of repair parts. Ironically, the repair parts needed to repair the deadlined engines and materials handling equipment (MHE) were aboard the ships awaiting discharge." The Army was also hard-pressed to provide sufficient quantities of engineer equipment to build the logistic base, and sufficient MHE to cope with the flood of cargo that was to pour into Vietnam. Tractors, scrapers, cranes, and forklifts of all makes and varieties were pulled from depots and units throughout the United States and shipped to Vietnam. In January 1966 there were 47 different makes and models of materiels handling equipment and 12 makes and models of bulldozers. At this time 36 percent of the 186 bulldozers and 26 percent of the 432 pieces of MHE were deadlined. The Red Ball Express was attempting to assist in the repair parts supply problem, amid the proliferation of makes and models which posed a maintenance nightmare. Work on standardization, which was considered the main problem, continued; by the end of September 1967, the goal of almost total standardization with only 7

[64] U.S. Army, Pacific, Annual Historical Summary: Part II, Southeast Asia, 1 January 1967-31 December 1967.

[65] Department of the Army, Deputy Chief of Staff, Logistics, Memorandum, subject: Equipment Maintenance, undated.

makes and models of MHE had been achieved. Standardization assisted both maintenance and supply support systems to respond to operational requirements and by 1969 the operationally ready rates for MHE met approved levels.[66]

(2) The problems experienced by the proliferation of makes and models illustrate the fact that standardization is essential to effective support of operational forces and that use of nonstandard or varied makes and models, when necessary, should be limited to CONUS activities.

i. Maintenance Personnel

(1) The personnel problems experienced by the Army worldwide were typical of the personnel problems which beset the maintenance effort in Vietnam. The problems were particularly acute in Vietnam because the quantity and complexity of the equipment to be maintained had increased measurably while the military capability to maintain the equipment in the field had not increased.

(2) The shortage of Army CONUS based military maintenance units along with the increased use of civilian personnel at the intermediate and depot levels of maintenance found experienced military maintenance men in extremely short supply throughout the conflict.[67] The number of maintenance personnel required as individual replacements and as filler personnel for the maintenance units that had to be activated precluded adequate training experience on some equipments. Individuals sent directly from service schools to direct and general support units were often inexperienced and had difficulty performing their maintenance level tasks without close supervision. Reportedly, periods of up to 4 months of on-the-job training were required before new school trained personnel were considered productive. Directly contributing to the shortage problem were the low retention rates and the lack of a CONUS base for employment of the experienced repairmen upon their return from overseas. It was found that many experienced repairmen returning from Vietnam were retrained or placed in secondary occupations because sufficient military spaces for their skill did not exist in CONUS.

(3) Amplification of the Army maintenance manpower problem may be found in Chapter X of this monograph.

j. NCR 500 Mechanized Stock Control System

(1) Evaluation and investigation by various agencies on maintenance operations, materiel readiness, and logistics systems arrived at a common finding: poor repair parts supply performance contributed to deficiencies in the combat readiness posture of Army units. The responsibility for providing repair parts to the using units is vested in a direct support maintenance unit. Since a DS maintenance unit supports many units, the number of items stocked at the DS level varies but could conceivably go as high as 15,000. Accounting for these items and having the right quantity at the right place at the right time is a difficult task.[68]

(2) To improve the combat readiness of Army units it was concluded that some type of accounting device would assist in performing the record keeping and stock control functions at the direct and general support level. In early 1965 a plan was devised which provided for testing to determine the relative merits of meeting certain objectives:

(a) Decrease time required in processing requests from using units.

(b) Maintain accounting records.

(c) Compute requisitioning objectives.

(d) Accumulate demand data on a more timely and accurate basis.

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[66] Army Materiel Command; Arsenal for the Brave; A History of the AMC 1962-1968.
[67] Department of the Army Report, Maintenance Manpower Requirements, 31 October 1969.
[68] Army Combat Developments Command Study: Direct Support Units/General Support Units, Phase II, Mechanization of DSU/GSU Supply Operations, December 1966.

(3) Tests were conducted at Fort Hood, Fort Carson, and Fort Lewis in division maintenance battalions during the fall of 1965, utilizing a computer processor at Fort Hood, less sophisticated mechanical equipment at Ft. Carson, and a manual operation at Fort Lewis.[69] The test at Fort Hood was the most successful in achieving the desired objectives, and impressively improved the stock status of the maintenance battalion and the using units.[70]

(4) As a result of the test, selected units on an expedited basis were provided with the NCR 500 computer processor which utilizes punched card programs and a readable magnetic ledger. Seventeen of these computer systems were installed in Vietnam between October 1966 and May 1967 in the first increment of an Army-wide mechanization program. An overall evaluation to determine mission effectiveness of DS maintenance units utilizing the NCR 500 as compared to DS units using the manual system was made in June 1967. It was concluded that DS units equipped with an automated system were capable of performing their mission more effectively than those not equipped. Specifically the results of analysis using the automated system revealed the following:[71]

(a) Time for processing the customers requisitions was significantly reduced.

(b) The computation of requisitioning objectives and assets due in and due out was extremely accurate.

(c) Demand accommodation increased by 24 percent and demand satisfaction increased by 14 percent.

(d) Zero balances decreased by 6 percent.

k. Red Ball Express (RBE)

(1) Project Red Ball Express was established as a result of a visit to Vietnam by the Secretary of Defense, Robert McNamara, in November 1965. At that time he was advised by USARV that difficulty was being experienced in keeping wheeled vehicles, MHE, light amphibious resupply cargo (LARC) vehicles, aircraft, and trucks over 5 tons operational. Deadline rate for lack of parts varied in this equipment from 20 to 40 percent.[72]

(2) On 2 December 1965 Department of the Army implemented the Red Ball Express system and directed the establishment of special supply and transportation procedures to expedite delivery of repair parts to remove equipment from deadline. The DA message directed that:

(a) Special procedures would be designated Red Ball Express.

(b) The Logistics Control Office-Pacific (LCO-P) would be the responsible agency to receive, process, expedite, and control all requisitions, including responsibility for airlift.

(c) Time for fill and delivery to Vietnam would not exceed seven days.

It was estimated the initial input of requisitions would be approximately 1,000 and 3,000 requisitions being received monthly. The average monthly receipts have far exceeded the 3,000 per month estimate, but this was due to extending the system in April 1966 to all deadlined equipment.

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[69] Research Analysis Corporation Study, An Evaluation of the NCR 500 Computer System in Vietnam, February 1968.

[70] Army Combat Developments Command Study: Direct Support Units/General Support Units, Phase II, Mechanization of DSU/GSU Supply Operations, December 1966.

[71] Research Analysis Corporation Study, An Evaluation of the NCR 500 Computer System in Vietnam, February 1968.

[72] Army Materiel Command, Briefing to General F. J. Chesarek, Red Ball Express, 8 May 1969.

(3) Red Ball Express procedures specified that Vietnam requirements be submitted to Logistics Control Office-Pacific (LCO-P) and Okinawa simultaneously. Okinawa would fill or kill the requisition and would provide shipment status to the LCO-P on the fills, whereby the LCO-P would cancel the requisition, time permitting. The function of the LCO-P was to convert requirements to requisition format, to dispatch the requisition to the responsible activity, and to follow up and maintain all status from the time the requisition entered CONUS until delivery of the item was made to USARV. All available assets were used to fill Red Ball Express requisitions, including fabrication, cannibalization, depot operating stocks, and existing procurement and production if required. In January 1967, Red Ball Express was expanded to include requisitioning of repair parts 15 days in advance of the date equipment was anticipated to be in a Not Operationally Ready Supply (NORS) status.[73] Under the Red Ball Express expanded system, USARV submitted requisitions for fill to the 2nd Logistical Command in Okinawa and requisitions not filled were passed to the LCO-P.[74] By 27 June 1969, 56,553 short tons consisting of 755,860 line requisitions had been lifted by Travis Air Force Base under the Red Ball Express and Red Ball expanded system.[75]

(4) Since the primary purpose of the Red Ball Express system was to reduce equipment NORS in Vietnam the measure of effectiveness is best related to the percentage of equipment deadlined. Since the NORS rate ranged from 20 to 40 percent in January 1966, Table 15 shows the trend of NORS in Vietnam from January 1967 to April 1969. The worldwide average is shown as of January 1969. Since 1967 there has been a significant reduction in NORS in Vietnam and in all cases the NORS rate is considerably lower than the worldwide average. Also included is equipment that has been deleted from USARV reports since the NORS has been below the established Department of the Army level for more than 90 days.

l. Overhaul Criteria. The high usage rate of combat vehicles in Vietnam provided the necessary data base for the evaluation of the maximum mean time between overhaul criteria which could be applied without a significant reduction in the average operationally ready rates. In the early phase M48A3 tanks were overhauled at 3,000 miles. This was increased to 4,000 miles and then to 5,000 miles. A 6,000-mile criterion is now under test. Similar progression was experienced with the armored personnel carriers. Initially 5,000 miles was established as the overhaul point; this was extended to 6,000 miles. A test is now being conducted at the 7,500 mile level. This has resulted in a savings of money, facilities and turnaround time, with the resources saved devoted to other urgent requirements.[76]

m. The Army Equipment Records System. The Army equipment records procedures have been revised, thereby reducing the administrative workload on field units through the elimination of Form 2408-3.[77] The latest change, effective 1 October 1969, has reduced the organizational reporting and recording effort at the crew/mechanic level by 80 percent and automatic data processing effort by 50 percent.[78]

n. Army Logistics Offensive

(1) There is an Army logistics offensive in the making. The offensive, in its broadest sense, is an Army-wide program designed to re-emphasize logistic principles, update and refine techniques, revise systems, and more clearly define training and career management objectives.

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[73] Department of the Army, Deputy Chief of Staff for Logistics, Annual Historical Summary, 1 July 1966-30 June 1967.
[74] Army Materiel Command, Briefing to General F. J. Chesarek, subject: Red Ball Express, 8 May 1969.
[75] Department of the Army, Deputy Chief of Staff for Logistics, Annual Historical Summary, 1 July 1968 to 30 June 1969.
[76] Department of the Army, Message 927884, subject: Overhaul Criteria for Tanks and Armored Personnel Carriers (U.S. Army, Pacific, 16 October 1969).
[77] Department of the Army, Message 923440, Equipment Maintenance Record, Organizational, subject: Elimination of DA Form 2408-3.
[78] Department of the Army, DCSLOG, Annual Historical Summary, 1 July 1968 - 30 June 1969.

TABLE 15

EQUIPMENT NORS—RED BALL EXPRESS
(%)

Equipment	Jan 67	Jan 68	Jan 69	Apr 69	Worldwide Jan 69
Bulldozers					
Full Track Tractor	11.3	4.3	10.9	7.5	15.7
Wheeled Tractor	12.0	2.9	10.0	8.4	11.2
MHE					
Commercial	19.2	7.4	10.2	4.5	
Rough Terrain	22.5	7.1	8.7	5.4	17.8
Trucks					
5-Ton CGO & Trac	5.7	4.5	6.5	3.3	11.0
5-Ton Dump	11.7	2.6	6.4	4.2	14.6

Deleted from USARV Report:

Aircraft	Artillery Sp:
Tank, M48A3	M107 - 175 MM
Personnel Carrier, M113	M108 - 105 MM
Vehicle Tank Recovery	M109 - 155 MM
LARC V	M110 - 8-Inch

Source: Department of the Army: U.S. Army Maintenance Board, Briefing to Gen F. J. Chesarek, subject: Red Ball Express, 8 May 1969.

(2) Improvement in maintenance management is necessitated by the growth of complex equipment and the high turnover of skilled personnel. Austerity in procurement authorizations has placed greater reliance on maintenance programs as a source of supply.

(3) Technological improvements in data automation, communications and transportation have enabled managers to develop support techniques, evaluate equipment reliability, create standards of performance, and influence design changes for the next generation equipment. The evaluation of equipment failure rates and the level of corrective maintenance required is influencing the maintenance support structure of the future, and has surfaced the development of the following:

(a) Maintenance accomplished under the Inspect and Repair Only as Necessary (IROAN) principle will be replaced by prescribed standards of maintenance.

(b) Under the maintenance support positive (MSP) program, maintenance responsibilities will be redefined. The major objectives of MSP are to perform maintenance through replacement of components and modules to the maximum extent within the state of the art, and to effect better utilization of maintenance resources. A prime factor being considered is the nonavailability of skilled maintenance personnel to maintain a growing complexity of equipment.

(c) A concept of mobile maintenance is being developed which will minimize the commander's burden. It will provide minimal user maintenance, a service station approach, contact teams, and air mobile maintenance shelters. The main objective is to provide maintenance where and when required with less proliferation of skills, parts, and test equipment.

(d) Engineering effort in the maintenance area has been largely concerned with equipment in the operational phase of its life cycle. Greater emphasis on maintenance engineering is being introduced into the conceptual and acquisition phase of the equipment life cycle.

(e) Equipment life extension will be accomplished selectively, by providing a tailored maintenance service at the mid-life point of the anticipated life expectancy.

(f) A project improvement is under way to more effectively develop and implement overhaul workload programs, and automate the techniques to measure performance against programs. This will provide the basis to measure the effectiveness of the DA Worldwide Depot Maintenance Program.

(g) One of the outstanding problems in the prompt classification of the economical repairability of items was the skills and time required. This must be accomplished prior to evacuation to maintenance facilities and subsequent return to the supply system. During September 1969 a Special Criteria for Retrograde of Army Materiel (SCRAM) was instituted in Southeast Asia. SCRAM provides simplified inspection and classification procedures for use in determining the condition and destination of materiel considered for retrograde. The results to date indicate that equipment is being classified and retrograded more promptly, utilizing less skilled personnel.

(h) Equipment operationally ready (OR) standards have been prescribed for a wide range of equipment by major command. The Army Equipment Record System (TAERS) data measure performance against these standards. Summaries are produced and, on an exception basis, highlight problem areas. This system provides management with a visibility as to equipment average OR rates worldwide. It reflects the degree of downtime attributable to supply and maintenance problems separately.

4. STRENGTHS, WEAKNESSES, AND LESSONS LEARNED

a. General

(1) Maintenance support for the combat forces although not without its problems during the initial stages of the Vietnam era, proved remarkably flexible and increasingly capable as the size of the Army force reached its peak. The support rendered by innovated systems, such as Red Ball Express and Closed Loop, proved that high operational readiness could be provided and maintained in a very unsophisticated environment.

(2) The experiences of maintenance support in Vietnam gave rise to the development of new techniques, standards, and concepts, as well as providing a very arduous testing ground for previous timeworn methods of performing maintenance. For the future, the importance of benefiting from the strengths, weaknesses, and lessons learned in maintenance cannot be overstressed.

b. Army Maintenance System. The effectiveness of the Army maintenance system in maintaining equipment operational readiness is evidenced by the high operationally ready (OR) rates that have been established in combat operations in Vietnam since 1967. High not operationally ready supply (NORS) rates were experienced in the early stages of the buildup; however, through the utilization of the Red Ball Express and Closed Loop Support system, significant reductions were made. The high OR rates shown in Table 7 exceeded in most cases rates for similar equipment in areas that were not involved in combat. In view of the large density of equipment involved, the environment in which it operated, and the long line of communications from the CONUS base, the results obtained from the Army maintenance system indicate that it was performing as required.

c. NCR 500 Stock Control. The use of the NCR 500 computer processor at the direct and general support maintenance level for the automated accounting of repair parts increased the combat readiness posture of Army units. Specifically, an analysis of the automated system revealed that:

(1) Time for processing the customers requisition was significantly reduced.

(2) Computation of requisitioning objectives and assets due in and due out was extremely accurate.

(3) Demand accommodation increased by 24 percent, demand satisfaction increased by 14 percent, and zero balance decreased by 6 percent.

d. Army Maintenance Capability

(1) The rapid expansion of the Army force structure and accelerated deployment of maintenance units created logistic problems in CONUS and in deploying units during the early days of the Vietnam buildup.

(2) The Army force structure had been organized on the assumption that, in a contingency the magnitude of Vietnam, the Reserve components would be mobilized. The decision not to call up the Reserve components had a serious impact on the force structure. The deployment during FY 66 of maintenance units without a concurrent increase of civilian personnel in the fixed field Tables of Distribution and Allowances (TDA) maintenance shops, which in some cases had been augmented by deployed units, reduced their maintenance capability. Because of the technical skills involved, replacing these units often proved more difficult than replacing the combat units.

(3) Although some maintenance companies remained uncommitted in CONUS, their maintenance capabilities had been drastically reduced by the drawdown of critical skills, tool sets, and test equipment which was necessary to equip and man the deploying units to their prescribed readiness condition. New TOE maintenance units had been activated during FY 66 but these were scheduled for deployment to Southeast Asia in accordance with the Army buildup plan. The Army buildup plan and the establishment of the Selected Reserve Force imposed additional maintenance workloads on the already overburdened CONARC maintenance capability. The maintenance units included in these programs were not able to increase their capability because of the long lead time required to train hard-skill military specialists and procure essential maintenance equipment. It was the consensus at CONARC that the provision of minimal maintenance support for both the Army buildup plan and the Selected Reserve Force would depend on the authorization of additional personnel spaces and funds to increase the commands fixed field maintenance capability, and also on the provision of technical assistance in all commodity areas. The possibility that Reserve components in future contingencies might not be mobilized should be considered in future plans.

e. Closed Loop Support. The ability of the Army to obtain visibility of selected items through the closed loop support system facilitated accurate depot maintenance programming and performance and constituted a major strength in the later phases of the Vietnam era. The effectiveness of this management technique is verified by the improved readiness rates of the forces and the return to inventory of critically needed reparables. Closed loop support identifies and measures performance of these segments as a means of improving control and performance.

f. Equipment Reliability

(1) Equipment to be used by troops in the field within a combat theater of operations must be reliable, maintainable (within allowable time limits), and must possess a certain degree of tolerance to abuse. The use and issue of equipment that does not perform satisfactorily in the field within prescribed standards create logistics problems that are difficult to overcome and could have a serious impact on combat readiness. It appears, from the unsatisfactory

performance experienced with the multifuel engines in Vietnam and other areas of the world, that reliability, maintainability, and tolerance to abuse were not inherent in these engines to the degree desired.

(2) The 5-ton family of vehicles, utilizing the multifuel engines has probably been the workhorse of the Vietnam conflict. It has contributed greatly to the success of combat operations, but at the same time the problems experienced with the multifuel engines have made the maintenance task more difficult. Problems concerning the multifuel engines included excessive failures of components, shortage of repair parts, and inadequate inspections which resulted in premature replacement and evacuation to a rebuild facility when only direct support maintenance was required. As a consequence the number of multifuel engines, costing approximately $3,200 each, required to support military operations in Vietnam was unnecessarily increased, as were transportation and rebuild costs.

g. Equipment Standardization. The requirement in Vietnam for marine craft, materials handling equipment, and construction equipment forced the Army to deploy all available assets with no capability to restrict the deployment to standard items. Deployed Marine craft were taken from reserve fleets which had been in mothballs since Korean War days. Materials handling and construction equipment consisted of various makes and models. Nonstandard and obsolete equipment caused serious repair parts shortages. Restockage was hindered by the age of the equipment, lack of current catalog data, and the low quantities of any particular model. Efforts were initiated to standardize materials handling and construction equipment in Vietnam and to limit the number of different makes and models. By 1968 standardization efforts had alleviated many of the problems in-country. Standardization of marine craft had not been practical in view of the limited assets available. Studies are being conducted to identify future Army requirements for this equipment and to form the basis for procurement of modern, standard craft.

h. Special and Test Equipment

(1) Adequate support for special and test equipment which was new to the Army Inventory was a perplexing problem: Turbine engine test stands, sonic cleaners, fuel control test stands, hydraulic test stands, and numerous avionics and armament test sets which were low density items in the supply system had in some cases only commercial catalogs and parts data supplied at time of purchases. Parts were not readily available in the supply system and aside from a quick-fix kit had to be supplied from the manufacturer. Long lead times for repair parts were not uncommon and often qualified personnel to determine the parts requirements and maintain the equipment were not available in-country.

(2) Initially, special and test equipment must be validated for use in an unsophisticated environment and then a complete logistics support package to include parts, tools, manuals, and qualified maintenance personnel must be provided concurrently with the introduction of the equipment into the inventory.

i. Personnel Qualification

(1) Maintenance personnel arriving in Vietnam for assignment to direct and general support maintenance units were, for the most part, incapable of performing intermediate level maintenance tasks without close supervision. Between 30 and 120 days of on-the-job training were required, depending on equipment complexity, before the individual was considered minimally proficient. Cause of the problem may be traced to lack of practical experience prior to assignment. The majority of replacement maintenance personnel were assigned directly from formal training programs and were not afforded an opportunity to work on equipment in the field in CONUS prior to a combat zone assignment. The number of military maintenance spaces authorized in CONUS at the intermediate and depot levels was not sufficient for the gainful employment of maintenance personnel being returned from overseas. The use of civilian employees predominantly in CONUS-operated intermediate and depot maintenance shops precluded the employment of military personnel and resulted in many individuals being employed in other than their primary occupational specialty.

(2) Principal reasons for a lack of quality personnel were shortage of military spaces in the CONUS rotational base, civilianization of intermediate level maintenance positions in CONUS, immediate and expanded requirement for maintenance personnel in Vietnam, and the use of contract maintenance in CONUS at the organizational and intermediate levels for aircraft.

(3) Maintenance personnel should be assigned to CONUS based intermediate level maintenance activities for a period of time prior to overseas assignment and a broadening of the CONUS rotational base is necessary so that an individual can be assured of continued utilization and development of his skill subsequent to an overseas tour.

j. Support Unit Reorganization

(1) Maintenance units deployed to Vietnam in 1965 and early 1966 were organized under the technical service concept and as a consequence were oriented toward the repair of specific Ordnance, Signal, Quartermaster, Transportation, Engineer, and Chemical equipment. The reorganization of maintenance units, beginning in late 1966, to encompass the COSTAR concept was a large undertaking that required deactivation of old units, activation of new units, realignment of functions, realignment of personnel, and redistribution of tools and equipment. A reorganization of such magnitude, particularly under combat conditions, involved a period of unavoidable turbulence in realigning support missions, transferring personnel and equipment, and accomplishing that unit training which was required to develop a cohesive composite support structure.

(2) An evaluation of the COSTAR concept revealed that the TOE for direct support maintenance companies, nondivisional, did not provide the required number of personnel and skills to perform maintenance on all equipments of field army units. Supply personnel were inadequate to perform repair parts supply functions and technical assistance visits could not be performed on a scheduled basis due to the lack of depth in military skills. In addition, functional areas of liaison and control of reparable items were not identified in the COSTAR TOE. Testing and field analysis of this new concept prior to implementation would have corrected many of these shortcomings.

5. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) The Army experienced difficulty in effecting the transition from peace to war, since a great number of required logistic units were structured in the Reserve components that were not called up. The decision not to call up the Reserves made it necessary to activate, equip, and train new Army units for intermediate maintenance requirements (paragraph 2c).

(2) Replacement personnel arriving in Vietnam, although CONUS-school-trained, were often inexperienced and had difficulty in performing their maintenance level tasks without close supervision (paragraphs 2a, 2c, 3c and 3i).

(3) The implementation of the Red Ball Express in December 1965 and Closed Loop Support system in November 1966 contributed greatly to the improvement of operational ready rates by increasing the availability of repair parts (paragraphs 2a, 3d, 3g, and 3h).

(4) The Army development of the Closed Loop Support System in November 1966 provided visibility of selected end items and reparables, and facilitated more accurate depot maintenance programming and performance (paragraphs 2c and 3d).

(5) The introduction of the NCR 500 computer processor in Vietnam in October 1966 at the direct and general support maintenance level for the automated accounting for repair parts increased mission effectiveness and contributed to the combat readiness posture of Army units (paragraph 3j).

(6) Contract maintenance performed a needed service throughout the Vietnam era as an augmentation to the military maintenance capability (paragraphs 3a and 3c).

(7) The Army used contract maintenance support extensively in the combat zone in Vietnam. This requirement was due to the inadequacy of the CONUS base to provide sufficient maintenance units or qualified personnel in the time frame required. Army aviation maintenance units, in particular, necessitated reliance on contractor maintenance personnel to augment their capabilities as a result of the large-scale buildup of the Army aviation program in USARV beginning in 1966.

(8) The effectiveness of the Army maintenance system is manifested in the high overall equipment availability rates beginning in the latter part of 1967 and maintained until the present. Army aviation maintenance performance was particularly noteworthy in view of the inherent maintenance problem evolving from an increase of 500 aircraft in 1965 to over 4,000 aircraft in 1969. FY 70 NORS/NORM rates for Army aircraft provided evidence of the value of Closed Loop Support, Red Ball Express, and Stovepipe systems (paragraphs 2a, 2b, and 3h).

(9) The unsatisfactory performance experienced with the multifuel engines in Vietnam and other areas of the world was an example of equipment that was designed without adequate reliability, maintainability, and tolerance for abuse (paragraphs 2a and 3g).

(10) The number of military maintenance spaces authorized at intermediate and depot levels has not been sufficient to provide an adequate rotational base to meet requirements of deployed forces (paragraph 3i). (See also Chapter X of this monograph.)

(11) The reorganization of maintenance units in Vietnam in 1966, to encompass the COSTAR concept, was a large undertaking that required deactivation of old units, activation of new units, realignment of functions, realignment of personnel, and redistribution of tools and equipment. A reorganization of such magnitude, particularly under combat conditions, involved a period of unavoidable turbulence in realigning support missions, transferring personnel and equipment, and accomplishing the unit training required to develop a cohesive composite support posture. The reorganization under a new concept which had not been tested or analyzed in the field revealed deficiencies that could have been corrected prior to implementation if testing or field analysis had been performed (paragraph 2c).

b. Recommendations. The Board recommends that:

(MT-1) The Army continue to expand and refine Closed Loop Support procedures and techniques to provide real-time visibility and control of intensively managed items (conclusions (3) and (4)).

(MT-2) The Army ensure that there is an adequately structured CONUS rotational base for military maintenance personnel (conclusion (10)).

(MT-3) The Services be specific in their planning on the necessity for contract maintenance personnel to augment an existing organic maintenance capability. Where contract maintenance augmentation is required, plans should address the following factors:

(a) The size of the contractor force to be utilized.

(b) The number of contractor firms proposed for employment.

(c) Geographical locations proposed for assignment of maintenance contractors (conclusion (7)).

(MT-4) The Army service test and evaluate new maintenance concepts prior to reorganization of support units (conclusion (11)).

CHAPTER IV
NAVY MAINTENANCE

1. GENERAL

a. Concept. Navy maintenance policies had their roots in the concepts of mobile support and maintaining maximum independence of fixed bases. The concepts of mobile support, developed in World War II and kept in effect and further refined by operating readiness, enabled the fleet to go into action immediately and sustain unprecedented continuous operations. In time of conflict, mobile support had the flexibility for rapid expansion tailored to the type and location of the operations. The concept of maximum independence of fixed bases required ships and aircraft of the fleet to be maintained combat capable and to be kept as self-sufficient as practicable. Ships and aircraft were able to deploy with little or no warning and operate independently or with other units for long periods of time in global implementation of national policy. The capabilities and resources available within each ship were designed to give this ability to the Commanding Officer. This concept was the basis for shipboard personnel maintaining the equipment they operated and governed shipboard and aircraft maintenance training, the depth of the onboard repair parts allowance, and quantity and scope of test equipment and tools carried. Maintenance management for U.S. Navy ships and aircraft was an inseparable part of the total responsibility and authority of command.

b. Maintenance Policies

(1) Navy maintenance policies are set forth in Chapter 20 of U.S. Navy Regulations and OPNAV Instructions. These policies were observed in planning and accomplishing maintenance of ships, craft, and aircraft in order that the material readiness of the fleet would be of the highest practicable order consistent with available resources.

(2) Implementation of the Navy's maintenance policy was directed toward maximum self-sufficiency within available capabilities and resources. In the management of maintenance, the Navy distinguished by differences in capability rather than by type or kind of maintenance performed. Because of the Navy's inherent worldwide long term separation from support bases, the capability for equipment maintenance was controlled through assignment of skills, tools, and parts. Specific maintenance and material support levels for all repair tasks were not established in the Navy, since such actions presumed the availability of standardized repair parts support capabilities for each maintenance level. Limitations of space and weight aboard ship further precluded establishment of common repair capabilities for all types of ships.

(3) Certain basic principles governed discharge of the maintenance function in the Navy. As in the other Services, all maintenance work must be performed at the lowest level commensurate with the availability and distribution of maintenance personnel, equipment, parts, and facilities. In addition, all skilled maintenance personnel should be used primarily in maintenance work. At the organizational level, military personnel were responsible for maintenance of the equipment possessed by the command consistent with the tools, test equipment, material, skill, and manpower available aboard ship. This level of maintenance was primarily preventive in nature, scheduled by the Commanding Officer with centralized technical guidance through the Navy's maintenance management system. Shipboard maintenance was continuous and ship's personnel were normally capable of performing any corrective repair to onboard equipment not limited by lift capability, drydocking, or need for special tools. Aircraft organizational level maintenance included a high percentage of reparable replacements repaired by the intermediate level which differed from shipboard maintenance requirements. Although intermediate level maintenance repair work aboard ship was essentially the same as that performed at the organizational level, the depth and degree differed. Except for very major repair work and drydocking, there was no real limit or rules on the intermediate capability which could be accomplished

at a given time. Therefore, an attack aircraft carrier, for example, could have nearly the self-repair capacity in tools and personnel as a repair ship.

(4) Depot level repairs were accomplished with a civilian work force at naval shipyards and aircraft rework facilities. No rigid rules existed and the maintenance work was usually negotiated between the user and the supplier with recognition that with few exceptions each ship and aircraft was an individual end item. The number of requests for depot maintenance was limited by the consideration that the using Type Commander was required to pay for the work from his own funds. Thus a Type Commander was encouraged to accomplish the maximum amount of maintenance with his own resources, and to resort to the more expensive higher level maintenance services only when in dire need. In summary, depot maintenance was a tradeoff between the time available at the organizational and intermediate level, funds available at the depot level, and the total capacity available at each level, rather than adherence to rigid rules specifying what was to be accomplished in each category. This represented a basic difference in maintenance management between the Navy and the other Services.

c. Organization for Maintenance. Navy-wide maintenance management was the ultimate responsibility of the Chief of Naval Operations, who was responsible for, formulated, and promulgated maintenance policy. The structure for handling maintenance activities at the organizational and intermediate levels began with the Chief of Naval Operations and proceeded directly downward through the Fleet Commanders to the force units. Subsequent to 1 April 1966, depot level maintenance responsibility flowed from the Chief of Naval Operations through the Chief of Naval Material through the appropriate Systems Commands to the continental United States (CONUS) depot facilities. The Chief of Naval Material had the actual responsibility for implementation and execution of maintenance policy and had direct control of depot maintenance in CONUS. He also provided the broad technical guidance for both organizational and intermediate maintenance, including that under operational command.

d. Maintenance Management

(1) The principal maintenance management system in the Navy was the Maintenance and Material Management (3M) system. Two separate systems were involved, one for ships and the other for aviation equipment.[1]

(2) The 3M system for ships consisted of the Planned Maintenance Subsystem (PMS) and the Maintenance Data Collection Subsystem (MDCS). Employing a "work study" approach, the Planned Maintenance Subsystem was designed to organize and systematize all preventive maintenance by more efficient use of scheduling and maintenance personnel. It provided a technique to balance the shipboard maintenance workload, yet gave the ship some flexibility in determining when the required maintenance task could best be done.

(3) The 3M system for aviation consisted of the Man-Hour Accounting Subsystem and the Aviation Maintenance Data Collection Subsystem, which provided local data products on a daily and monthly basis and was to a great extent the Navy's counterpart of the Air Force 66-1 system. The Man-Hour Accounting Subsystem recorded only maintenance nonproductive time to assist in balancing the work force to meet the direct labor requirements recorded in the Aviation Maintenance Data Collection Subsystem.

(4) The Maintenance Data Collection Subsystem for both ships and aviation had the objective of recording maintenance information that was of value to managers at all levels. The data were collected at a central data processing center, where the data elements were structured into a format suited to the requirements of individual commands both afloat and ashore.

[1]Chief of Naval Operations Instruction 43 P2, Maintenance and Material Management Manual; Naval Aviation Maintenance and Materiel Management Manual, 15 November 1964.

(5) The 3M system was a sound maintenance system with particular success in the PMS for ships and in the Aviation Maintenance Data Collections Subsystem. A more systematic approach has been taken toward the MDCS for ships, but full benefits have not been attained.[2]

e. Personnel Training. Military personnel training in the Navy was under the management control of the Chief, Bureau of Naval Personnel. Navy enlisted training included basic training for all new personnel followed by specialized trade or functional training which provided a foundation in fundamentals as well as the development of a technical proficiency. The changing and unforeseen requirements during the Vietnam era often required rapid cross-training by enlisted technicians on new equipment or, in some cases, equipment that had previously been retired from service. Emphasis was placed on the use of initiative and self-reliance with the tools and facilities available. The ability of afloat and ashore maintenance activities to effectively support a wide variety of equipment was possible only through the responsiveness and flexibility of maintenance personnel in applying their training skills to the new requirements.

2. SHIPS AND CRAFT

a. Problems Affecting Navy Ship's Maintenance

(1) Uniqueness of Individual Ships

(a) Each ship was identified as a unique weapons system, unlike a production item such as a tank or aircraft. Ships were complex, self-sufficient, and inhabited. They were built no longer or larger than necessary for the weaponry they contained. Even during shipyard overhaul periods, crews normally remained with their ships, and facilities for habitability were continuously maintained.

(b) A majority of the Navy ships in the fleet were constructed during World War II in accordance with varied military and commercial specifications. No two ships, even of the same class, were alike because different makes of noninterchangeable equipment were installed in otherwise identical ships. Extensive modifications have occurred to the ships constructed during World War II to meet changing missions and tasks. Most older ships could not be further economically converted or modernized to accept current and planned weapons systems. Their size, configuration, limiting electrical generating capability, or inherent speeds made them unsuitable. Because of space and weight limitations, there was no growth left in the older ships to continue adapting to meet changing threats.

(c) Subsequent to World War II, the U.S. Navy's annual shipbuilding program had been piecemeal and fragmented. Authorization for construction and conversion of small numbers of ships required individual congressional approval and emphasis was placed on distributing shipbuilding awards to many private and government shipyards. Small businesses were encouraged to participate and wide latitude was given the shipbuilder in the contracts and specifications for selecting equipment vendors and subcontractors. As an example, between 1951 and 1963 a total of 109 destroyer-type ships were built by the Navy in nine private shipyards and three government yards under separate contracts; not one called for more than four ships. A great lack of shipboard equipment standardization resulted.

(2) Lack of Ship Component and Equipment Standardization. The maintenance problems experienced during the Vietnam era on both older and post-World War II constructed ships brought the problems generated by lack of component and equipment standardization into sharp focus. The lack of standardization multiplied the numbers of repair parts which must be carried aboard ship and in supply inventories which in turn requires a greater inventory investment.[3] A Logistics Management Institute study reported that installed equipments within given classes of ships ranged from a low of 38 percent to a high of 58 percent equipments peculiar to

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[2] Joint Logistics Review Board, Briefing by Naval Material Command, subject: Navy 3M System for Ships and Aircraft, 20 August 1969.

[3] Carl B. Ihli, "Spare Parts, A Fleet Dilemma," Naval Engineers Journal, June 1967, p. 419.

individual hulls.[4] Improvement programs for standardization in older ships were not practicable once the ships were built and were only accomplished when funds permitted replacement for other reasons. However, in recent years, steps have been taken to require more standardization in new ship construction.

(3) Age of Ships

(a) The advanced age of a majority of the ships in the fleet had escalated the maintenance necessary to keep the ships operational. A foremost problem was the deterioration of the basic hull structure of the older ships. The hulls were developing weaknesses from the cumulative effects of corrosion and the stresses imposed over years of operation. As an example, the USS WALKER, a World War II 2,100-ton class destroyer, was unable to complete a deployment without major hull repairs. A serious hull deterioration problem existed beneath the ship's boilers which was eroding and corroding the ship's bottom dangerously thin. Because of the hull shock being experienced from ship's gunfire, the ship had to be drydocked and some hull plating replaced to prevent possible flooding.[5]

(b) Frequent breakdowns in older ships also occurred with the main propulsion units, water making plants, electrical generating equipment, piping systems, diesel engines and ship's boilers. The aggregate was that the older ships were less reliable and more expensive to maintain both in terms of dollars and manpower. The projeoted numbers of ships for FY 70 (shown below) reflect the mothballing or scrapping of approximately 130 ships, which would reduce the average ship age to 16 years:[6]

Date	Active Ships
1963	857
1964	859
1965	880
1966	909
1967	931
1968	902
1 January 1969	894
30 June 1970	771 (projected)

The age of a ship by itself is not significant. However, the combination of supporting older ships through years of marginal maintenance funding, increased tempo of operations with reduced time available for maintenance, and a critical personnel situation all contributed to an increasing maintenance workload and repair costs throughout the Vietnam era.

(4) Obsolete Shipboard Equipments

(a) Obsolete and obsolescent equipments aboard Navy ships had been a major drain of maintenance resources. Old parts were difficult to find in or outside the supply system. Many equipment manufacturers were no longer in business and repair parts were not available,

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[4] U.S. Naval Material Command, Selected Aspects of Ship Systems Engineering, May 1969, p. 1.
[5] U.S. Congress, House of Representatives, Hearing Before the Special Subcommittee on Southeast Asia, Committee on Armed Services, Status of Naval Ships, 90th Congress, Second Session; 91st Congress, First Session, October 1968, January 1969, p. 289.
[6] Office of the Chief of Naval Operations, Division of Plans and Programs, OP 302, Data on Numbers of Active Navy Ships During the Vietnam Era, Mr. H. W. Foote, September and November 1969.

or had to be purchased from speculators at excessive costs. If the repair parts were not available, the alternatives were to replace with new equipment or proceed with expensive and time consuming in-house manufacture. Additionally, many of the older converted auxiliary and amphibious transport ships lacked technical manuals, repair parts list identification, and drawings for their obsolete shipboard equipment, which further burdened maintenance support.

(b) Absence of detailed plans also occurred because of denial by some equipment manufacturers to release or sell proprietary plans to the Government. Support of obsolete shipboard equipment resulted in greater maintenance costs which can be expected to continue until the equipment is replaced. Funding levels in the past have precluded any major replacement programs.

(5) Corrective Maintenance on Older Ships

(a) The problems affecting maintenance of older ships can be best illustrated by examples of actions necessary to ensure margins of safety and reliability in Service Force ships during the Vietnam era.[7]

1. Mass replacement of piping systems, particularly salt water and steam drain systems was not uncommon. It was normal to replace 50 to 70 percent of the sanitary drains in all older ships and 100 percent of the steam drains from deck machinery in fleet oilers during overhaul.

2. As the insulation in main propulsion motors and generators in salvage ships, gasoline tankers, and fleet ocean tugs reached their 20-year life expectancy, complete motor and generator rewinds, at a cost of approximately $200,000 per ship, were found necessary and accomplished as funding permitted.

3. Exposed electrical wiring on the tank deck in fleet oilers and gasoline tankers required complete replacement to prevent electrical fires.

(b) The effect of the high tempo of operations on material readiness was profound. The increased number of cycles of operation combined with the reduced time for preventive maintenance increased the repair requirements in some areas almost twofold. The following specific examples are from the Service Force, U.S. Pacific Fleet:

1. In FY 67 it was necessary to overhaul 100 percent of the deck machinery in ships in regular overhaul. Prior to the increase in the tempo of operations, the usual requirement had been to overhaul only 50 percent of the deck cargo winches and controls.

2. Cargo fuel tanks, particularly JP-5 and aviation gasoline tanks were sandblasted and preserved during each overhaul, in contrast to FY 65 when such overhauls were needed and accomplished on only 50 percent of these tanks.

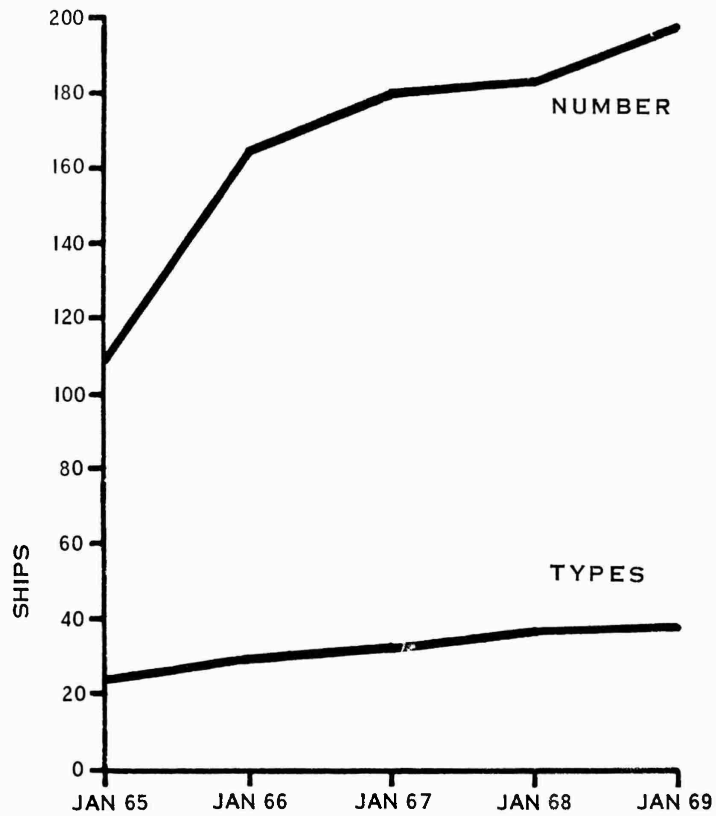
b. Impact of the Vietnam Conflict on Pacific Fleet Maintenance

(1) Increased Tempo of Operations and Size of Seventh Fleet

(a) The combination of aging ships, increased numbers of ships operating at high tempo, and the importance of maintaining a high state of readiness forcefully increased maintenance requirements at all levels. The steaming hours of Seventh Fleet ships increased 53 percent from FY 64 to FY 66 and SE Asia naval operations extended ship deployments from 6 to 11 months in the Western Pacific (WESTPAC). Ships experienced unprecedented usage of equipment and ship utilization in WESTPAC increased 26 percent, with an equivalent decrease in shipboard maintenance time. The maintenance impact of accelerated operations further complicated the problem of determining the best utilization of the decreasing turnaround time between deployments.

[7] Operations of Service Force, U.S. Pacific Fleet, Fiscal Year 1967, 11 July 1967, p. 20-3.

(b) The Seventh Fleet almost doubled in size from an average of 115 ships in January 1965 to a peak of 207 in 1969. Figure 4 shows the growth in numbers and types of Seventh Fleet ships in SE Asia during the Vietnam era. The Atlantic Fleet provided support with ships which were deployed to the Pacific Fleet by permanent transfer and by rotation.

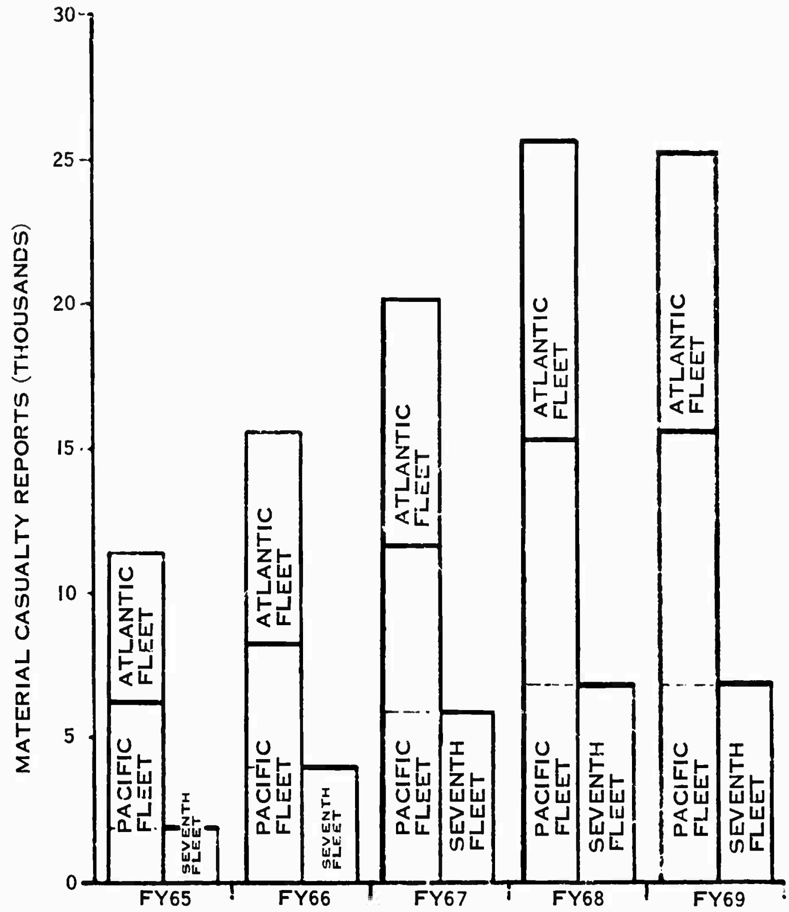


NOTES: 1) TOTALS LISTED DO NOT INCLUDE SALVAGE CRAFT IN HARBOR CLEARANCE UNIT ONE.
2) PEAK FORCE LEVEL WAS 207 SHIPS IN FY 69.
3) TOTALS LISTED DO INCLUDE IN-COUNTRY COMBAT OR SERVICE CRAFT.

FIGURE 4. SEVENTH FLEET GROWTH IN NUMBER AND TYPES OF SHIPS

Source: U.S. Navy, Office of Chief of Naval Operations, CNO Backup File 2703, 3 February 1969.

(2) Equipment Casualties. The factors outlined above and continuous operation under the severe climatic conditions in SE Asia subjected the ships and their equipments to severe tests. Operational casualties increased. In FY 67, for example, 29 major incidents occurred: 26 collisions and groundings, and three fires. During the 10-year period from 1958 to 1968, a twelvefold increase of casualty reports occurred. Figures 5 and 6 provide a summary of total material casualty reports from the Atlantic, Pacific, and Seventh Fleets during the Vietnam era. Major ship equipment casualties which required intermediate or depot level repair assistance normally imposed extensions at sea on the remaining ships. These conditions often necessitated major repairs in WESTPAC. Every effort was therefore directed toward ensuring reliable operation. Inspections were conducted in all ships upon return from WESTPAC to determine the work necessary prior to the next deployment. Such major inspections had previously been scheduled only before overhauls.



NOTES: 1) PACIFIC FLEET TOTALS INCLUDE THE SEVENTH FLEET
2) READINESS CATEGORIES – C–2 – SUBSTANTIALLY COMBAT READY
C–3 – MARGINALLY COMBAT READY
C–4 – NOT COMBAT READY

FIGURE 5. ATLANTIC, PACIFIC, AND SEVENTH FLEET MATERIAL CASUALTY REPORTS FOR READINESS CATEGORIES C-2 THROUGH C-4

Source: Rear Admiral D. H. Jackson, USN, CINCPACFLT Maintenance Officer, Statistics for Pacific and Seventh Fleet at Pearl Harbor, Hawaii, December 4; and Rear Admiral E. A. Grantham, Office of Chief of Naval Operations, Memorandum, subject, Deferred Maintenance, 28 October 1969, Enclosure 2.

(3) Maintenance Funding

(a) Pacific Fleet

1. The funding impact of Southeast Asia operations became increasingly apparent in the fall of 1965. In November, the Pacific Fleet in-depth overhaul program was discontinued because financial resources were such that it was only possible, with maximum reprogramming authority, to stretch maintenance funds until April 1966. Because of the lack of cash assets, it was necessary to resort to the extensive use of Commander's Orders to proceed with repair work at naval shipyards. A Commander's Order was an authorization by a Shipyard Commander to proceed with reimbursable work with a promise from competent authority that funds would be forthcoming. By 30 April, the Pacific Fleet had $21,600,000 outstanding in

Commander's Orders at various naval shipyards.[8] Available Pacific Fleet cash assets were used to fund the large amount of commercial industrial facility work, since Commander's Orders cannot be utilized with contract maintenance. Pacific Fleet funding was augmented early in April 1966, which provided the resources for the remainder of the fiscal year.

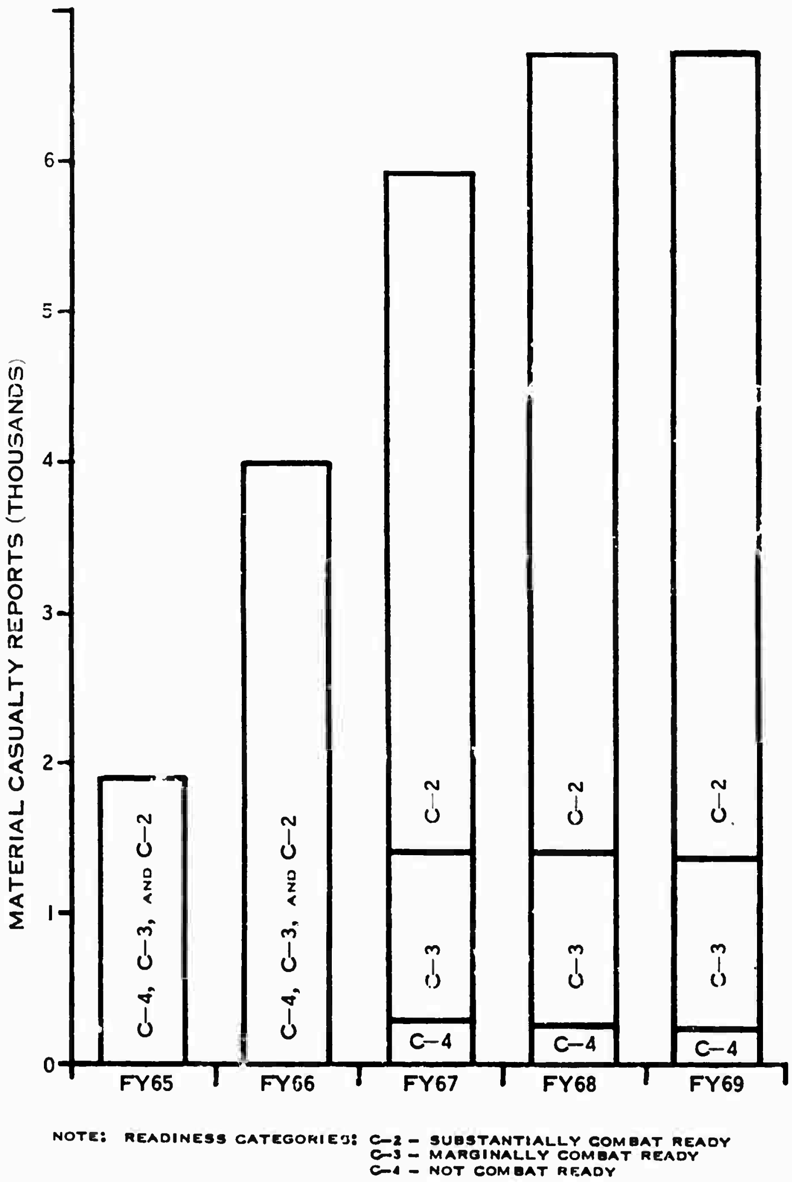


FIGURE 6. SEVENTH FLEET MATERIAL CASUALTY REPORTS FOR READINESS CATEGORIES C-2, C-3, AND C-4

Source: Rear Admiral D. H. Jackson, USN, CINCPACFLT Maintenance Officer, Statistics for Pacific and Seventh Fleet at Pearl Harbor, Hawaii, December 4, 1969.

[8] Operations of the Service Force, U.S. Pacific Fleet, Fiscal Year 1966, 14 September 1966, p. 19-7.

2. Casualty correction reflected in nonscheduled repair costs continued to rise. Figure 7 provides the restricted and technical availability fund expenditures for nonscheduled repair work at the Western Pacific Ship Repair Activities from FY 65 through FY 69. Because of the use of indigenous labor in the Philippines and Japan and indirect Filipino hires at Guam, repair work in WESTPAC cost less. Figure 8 provides a comparison of man-day costs at Pacific industrial activities. A threefold to sixfold increase in funding would have been necessary had the work identified in Figure 7 been accomplished in CONUS. It is emphasized that the Navy work done in WESTPAC was not done because it was inexpensive to do so, but because the work had to be done in that location; i.e., deployed ships needed repair to operate.

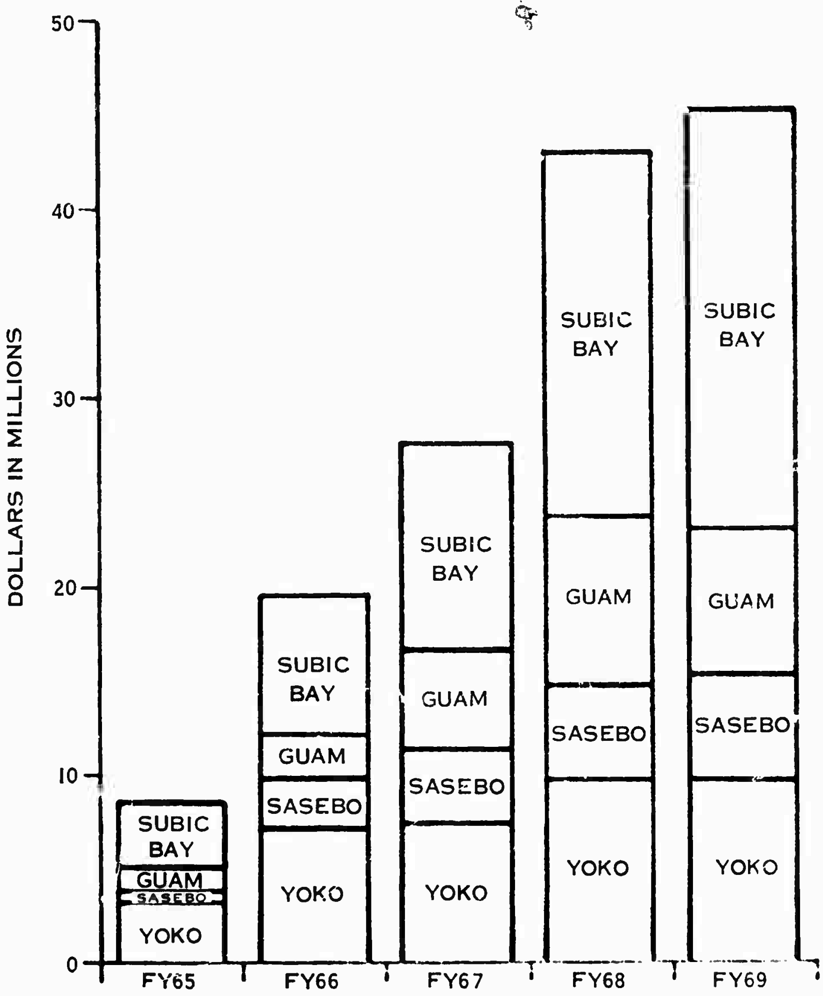


FIGURE 7. WESTERN PACIFIC SHIP REPAIR FACILITY RESTRICTED AND TECHNICAL AVAILABLE FUND EXPENDITURES

Source: Operations of the Service Force, U.S. Pacific Fleet, FY 68, 1 September 1968; Statistics from Service Force for Fiscal Year 1969, 4 December 1969.

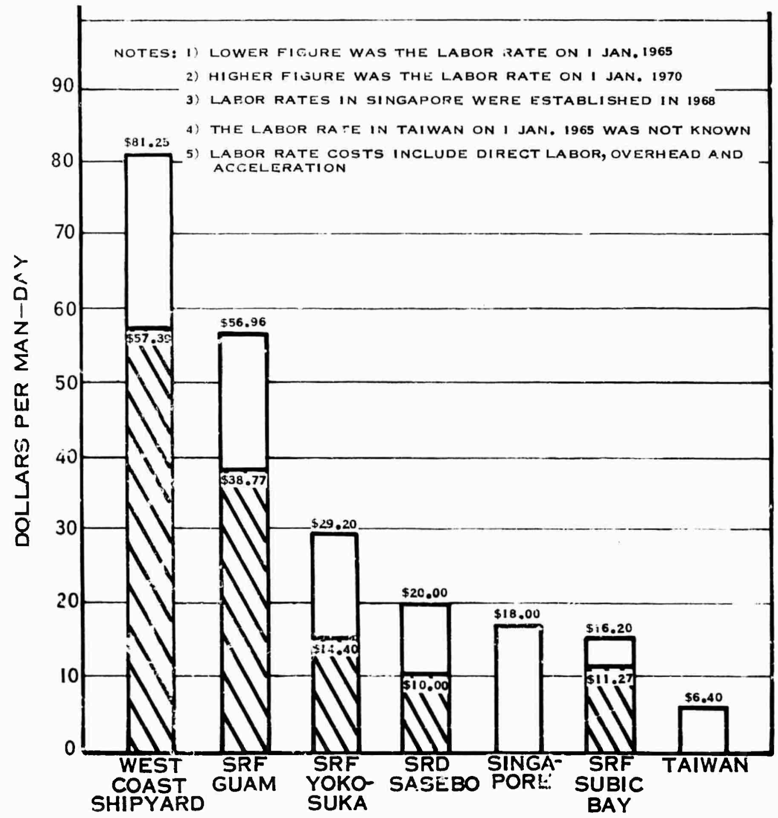


FIGURE 8. LABOR RATE COST COMPARISON AND GROWTH DURING VIETNAM ERA

Source: Rear Admiral D. H. Jackson, USN, CINCPACFLT Maintenance Officer, Interview held at Pearl Harbor, Hawaii, 2-4 December 1969.

3. Vigorous actions were required at all levels to ensure that necessary financial resources were available when and where required. This meant timely reprogramming actions and presentations to the primary support sources of valid justifications in support of new and rapidly expanding requirements. The untiring efforts by all levels in the Navy were rewarded by highly responsive fund support for urgent requirements as they developed during the course of the Vietnam conflict.

(b) Pacific and Atlantic Funding Posture During the Vietnam Era

1. Tables 16 and 17 provide financial summaries of the Navy's ships nonscheduled repair budget and expenditures for FY 64 through FY 69. In FY 66, an additional $63.3 million was necessary above the funds apportioned, which reflected the increased tempo of operations and the additional resources necessary to correct casualties to ship's equipment and hull structure. This was a quantifiable amount of deferred maintenance identified from years prior to the Vietnam buildup. A peak of $198 million was spent in FY 68, representing a threefold increase since FY 64.

TABLE 16

SUMMARY OF SHIPS RESTRICTED/TECHNICAL AVAILABILITY FUNDING, FY 64-69
(Millions of Dollars)

Funding	FY 1964	FY 1965	FY 1966	FY 1967	FY 1968	FY 1969
Originally Requested by the Fleet CINCs	68.7	70.4	81.6	89.8	169.3	243.3
Requested of OSD by the Navy Department	59.6	69.6	80.8	97.1	162.4	198.4
Submitted to the Congress	60.3	68.6	70.8	90.2	128.3	185.5
Apportionment	59.7	68.0	70.4	137.3	155.7	185.5
Actually spent	63.3	80.2	134.1	159.3	198.0	166.5

Source: Office of the Chief of Naval Operations, Memorandum, Logistics Posture at Start of Vietnam Build-up Maintenance Support, Ships, 23 June 1969; Statistics on Ship's Depot Level Maintenance Funding FY 66-69, 1 October 1969.

TABLE 17

SUMMARY OF SHIPS OVERHAUL FUNDING, FY 64-69
(Millions of Dollars)

Funding	FY 1964	FY 1965	FY 1966	FY 1967	FY 1968	FY 1969
Originally Requested by the Fleet CINCs	265.0	307.0	266.8	323.7	421.2	607.8
Requested of OSD by the Navy Department	248.7	225.6	245.0	323.7	397.5	602.5
Submitted to the Congress	200.4	200.7	245.0	283.0	361.0	547.9
Apportionment	200.4	214.4	243.8	366.0	391.2	547.9
Actually spent	183.8	246.1	289.0	391.7	397.0	428.8

Source: Office of the Chief of Naval Operations, Memorandum, Logistics Posture at Start of Vietnam Build-up Maintenance Support, Ships, 23 June 1969; Statistics on Ship's Depot Level Maintenance Funding FY 66-69, 1 October 1969.

2. A regular ship's overhaul was planned maintenance at a naval shipyard or a private commercial shipyard, normally scheduled in advance in accordance with an established cycle. When this cycle was exceeded, the overhaul costs could be expected to increase. Table 18 provides a financial summary of the Navy's ship overhaul budget and expenditures for FY 64 through FY 69. Table 18 summarizes the number of ship overhaul deferrals which occurred during the same period. Using FY 65 as a baseline, the average overhaul cost for each ship increased approximately 50 percent by the end of FY 69. The growth in cost was attributed to higher shipyard operating and labor costs, higher cost of materials and commercial services, and a significant increase in the amount of work necessary to attain an acceptable ship's material readiness condition.

3. Ship alterations are changes in the hull machinery, weapons, and electronic equipment or fittings which involve a change in design, materials, number, or locations. Ship alterations update ship's equipment, and install new weaponry to meet changing requirements. The Vietnam buildup caused a dynamic change in technology, principally in weapons systems, electronics, and electronic countermeasure systems. A review of ship alteration funding between FY 65 and FY 69 disclosed a $814.6-million funding shortfall between the amount originally requested by Naval Ships System Command and the amount actually spent during this

period.[9] This figure reflects the technological lag in meeting military requirements in Navy ships.

TABLE 18

SUMMARY OF NAVY SHIPS OVERHAUL DEFERRALS, FY 64-69

Fiscal Year	Originally the Number Requested by Fleet CINCs	Number Actually Accomplished	Number Deferred
1964	399	239	160 (Interim overhaul program terminated)
1965	430	231	199
1966	251	203	48
1967	269	270	
1968	260	232	28
1969	283	194	89

Source: Office of the Chief of Naval Operations, Memorandum, Logistics Posture at Start of Vietnam Build-up Maintenance Support, Ships, 23 June 1969, Statistics on Ship's Depot Level Maintenance Funding FY 66-69, 1 October 1969.

4. Throughout the Vietnam era there were insufficient funds available to allow ships to procure their allowances of repair parts. This problem stemmed in part from inadequate funding levels in the Navy's stock fund derived from a policy largely based on the ratio of sales to inventory. This rotating fund was made available to establish inventories from which parts were drawn, and through distribution points, were made available for placing aboard ships and responding to casualty reports. When the corpus of the fund was not large enough, fleet supply support was inhibited. As of January 1969, the Atlantic Fleet had approximately $32 million of unfilled combatant ship requisitions for repair parts. Another $9.3 million in requisitions were unfilled for Atlantic Fleet tenders and repair ships. This totals approximately $42 million in stock fund deficiency for the Atlantic Fleet alone.[10]

5. Prior to the Vietnam buildup, unfunded industrial maintenance requirements fell upon forces afloat. With a limited afloat maintenance capacity, much maintenance could not be done. When the Vietnam buildup commenced, the backlog of deferred maintenance and the advancing age of the fleet worked at cross-purposes with the increased tempo of operations which provided less time for maintenance by forces afloat. Thus constrained, shipboard maintenance became largely a matter of corrective, vice preventive, maintenance by overworked ship maintenance personnel. This had the adverse effect of reducing the retention rates in the shipboard maintenance areas that required the most attention, such as boilers and machinery. Equipment casualty rates and the number of nonscheduled repair work items increased significantly, making it mandatory that sufficient funds be channeled to provide the industrial support necessary to enable the fleet to carry out its mission. Studies have substantiated that higher restoration costs occur because of maintenance deferrals; however, insufficient data were available to quantify this for Navy ships during the Vietnam era. In summary, failure

[9] Office of the Chief of Naval Operations, Memorandum, subject: Logistics Posture at Start of Vietnam Build-up Maintenance Support, Ships, 23 June 1969; Statistics on Ship's Depot Level Maintenance Funding FY 66-69, 1 October 1969.

[10] U.S. Congress, House of Representatives, Hearing Before the Special Subcommittee on Southeast Asia Power at the Committee on Armed Services, subject: Status of Naval Ships, 90th Congress, Second Session, 91st Congress, First Session, October 1968, January 1969, p. 381.

to provide adequate maintenance funding prior to the Vietnam buildup was a major and costly weakness.

c. Support of Ships and Craft in the Western Pacific During the Vietnam Era

(1) Pacific Fleet Organization for Maintenance and Command Relationship

(a) The policy and basic direction for Pacific Fleet logistics stemmed from the Commander in Chief, U.S. Pacific Fleet (CINCPACFLT). There was a major delegation to the principal logistic agent, Commander, Service Force, U.S. Pacific Fleet (COMSERVPAC), under policies set by CINCPACFLT. As the principal logistic agent, COMSERVPAC was charged with responsibility for supervision and coordination of the planning, conduct, and administration of logistic functions, services, and supply of material to the fleet. Except for those logistic functions specifically assigned to other commanders under that Agent, there was an overall integrated operational logistic support system. Within the operating forces, appropriate logistic responsibilities accompanied other responsibilities for readiness. Each Type Commander had responsibilities for the logistic readiness of ships and units under his command.

(b) On 1 January 1965, the placing of WESTPAC U.S. Navy Ship Repair Facilities, Naval Supply Depots, and other support activities under COMSERVPAC placed logistic shore activities under the same fleet command as the mobile support forces. The assignment of these command responsibilities, coupled with responsibilities as Principal Logistic Agent for CINCPACFLT, greatly contributed to the responsiveness, flexibility, and efficiency of logistic support, not only of the fleet, but of other forces as well.[11]

(c) Figure 9 depicts the many resources which may be used to manage and direct repair to ships in WESTPAC.[12] Commander, Service Group Three, was tasked with coordination of afloat and ashore repair facility work allocations in the Western Pacific and commanded the mobile logistic forces of the Seventh Fleet as Commander Task Force 73. In order to provide in-port logistic service assistance, Commander Task Force 73 established mobile support unit detachments at seven logistics ports in WESTPAC which might or might not be active at any one time. An important maintenance responsibility was to screen work requests submitted by ships and authorize their accomplishment by afloat or shore assets in accordance with priorities set by COMSERVPAC.

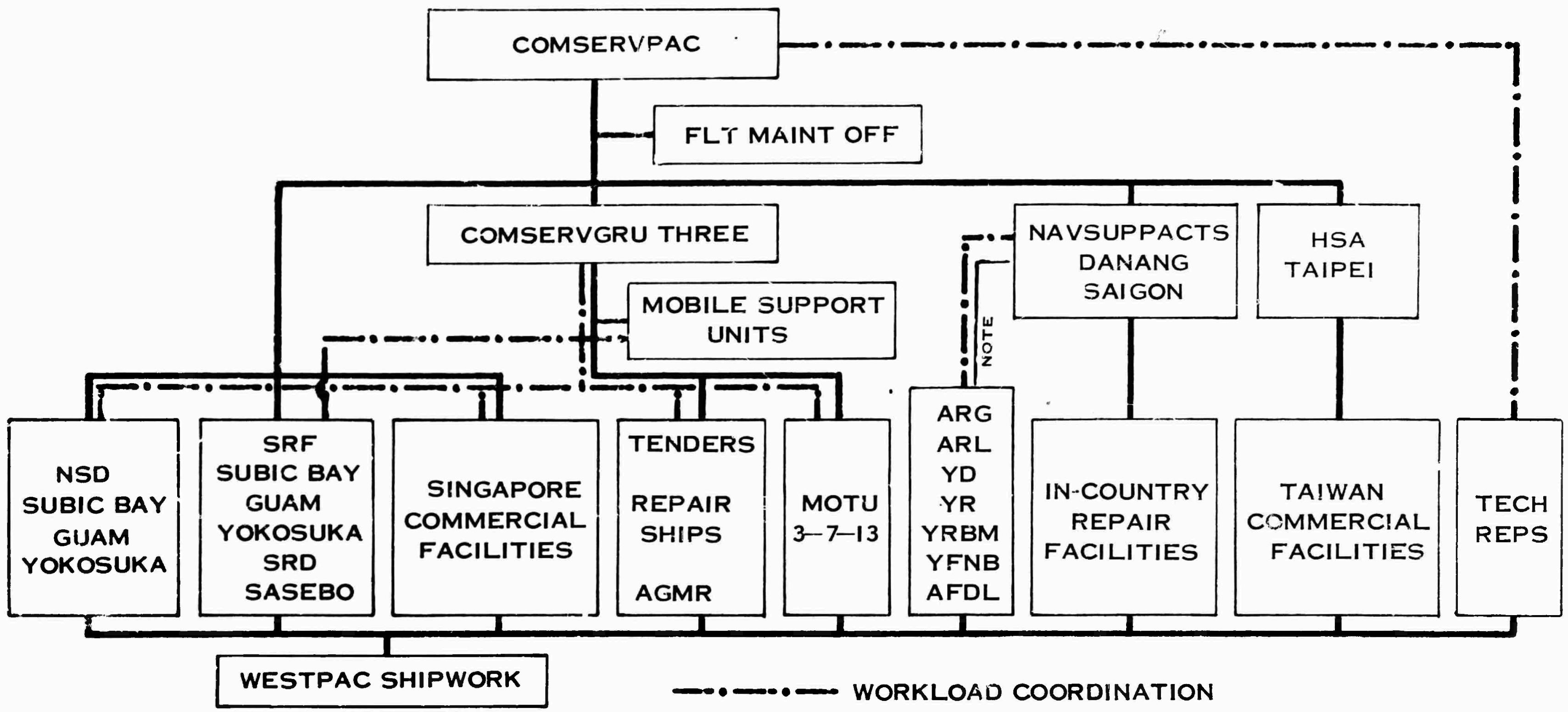
(2) Repair Ships and Tenders

(a) In order to support the increasing force level, the number of Seventh Fleet tenders was increased from three to four, with emphasis on effective utilization in the South China Sea area. The ability of the mobile repair ships to augment existing shore facilities, when and where needed, was no less important than their mission to provide repair support where no other facilities existed. Because of its proximity to the center of gravity of fleet operations and the variety of support there, Subic Bay experienced the greatest number of fleet unit port visits. As many as three repair ships at one time have operated there, with two repair ships present at least 60 percent of the time in 1967 and 1968 to assist with the heavy workload. The productive repair workload of Pacific Fleet repair ships and tenders during the Vietnam era is shown in Figure 10.

(b) Except for upkeep periods, the landing craft repair ship USS KRISHNA (ARL 38) provided repair support for Market Time operations at An Thoi in Vietnam continuously from September 1965. The transfer of the internal combustion engine repair ship USS TUTUILA (ARG 4) from the Atlantic Fleet to the Pacific Fleet provided maintenance support for Market Time and Game Warden operations at Vung Tau in Vietnam. In 1966, the landing craft repair ship USS ASKARI (ARL-30) was activated and deployed in-country for support of the

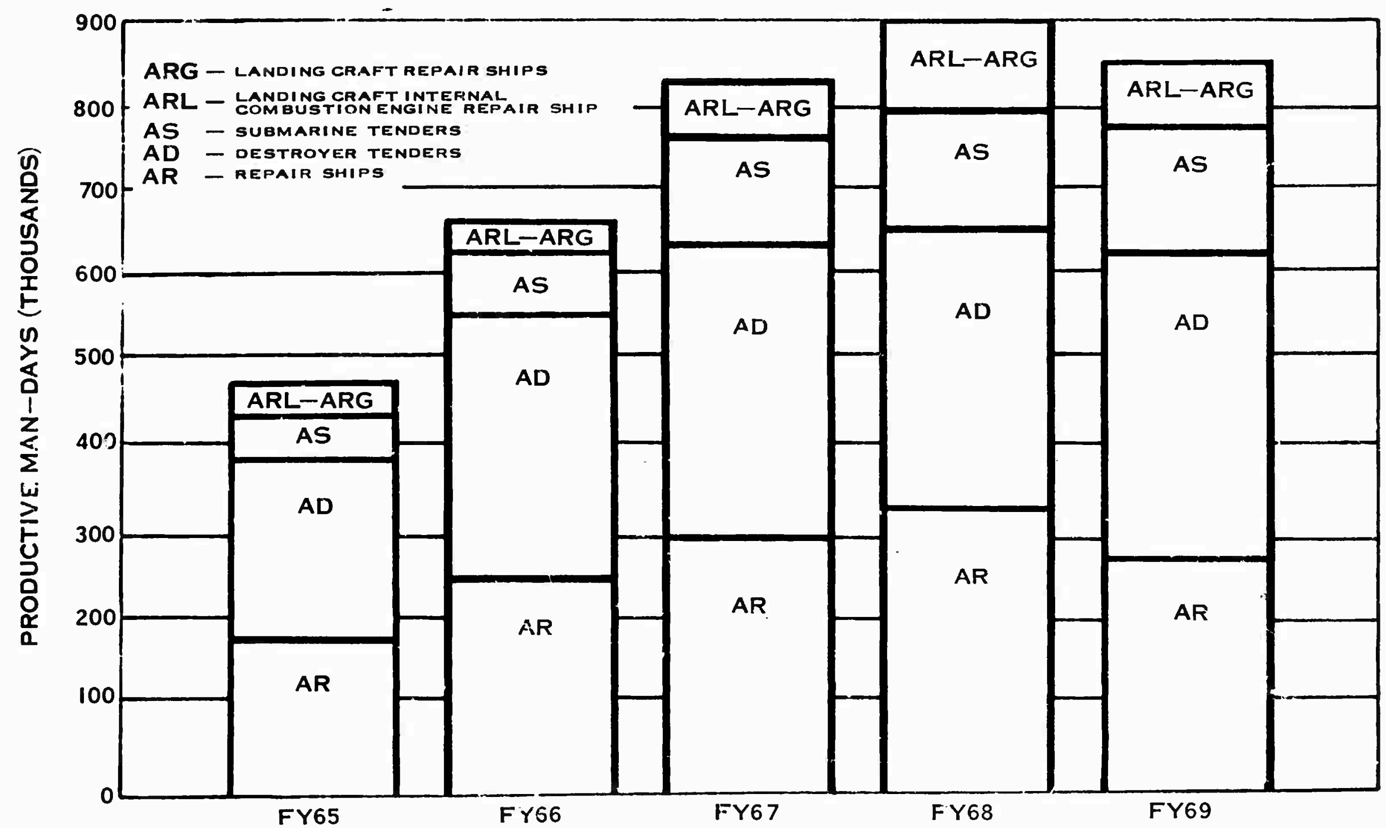
[11]Rear Admiral Edwin B. Hooper, USN, Address at Naval War College, subject: Logistic Support of Naval Operations in the Western Pacific, 30 March 1967.

[12]Admiral D. H. Jackson, USN, CINCPACFLT Maintenance Officer, Interview at Pearl Harbor, Hawaii, 4 December 1969.



NOTE: THE ARG ARL, YRBM AND OTHER CRAFT AS NECESSARY ARE NORMALLY ASSIGNED TO MARKET TIME AND RIVERINE TASK FORCE UNDER COMNAVFORV AS ORGANIC REPAIR CAPABILITY

FIGURE 9. PACIFIC FLEET, SERVICE FORCE, RESOURCES FOR SEVENTH FLEET REPAIRS SHOWING WORKLOAD COORDINATION RESPONSIBILITIES



NOTE: TOTALS LISTED ARE FOR WORK ON OTHER SHIPS AND DO NOT INCLUDE WORK EXPENDITED BY THE REPAIR SHIP TENDER ON ITSELF.

FIGURE 10. PRODUCTIVE REPAIR WORKLOAD OF PACIFIC FLEET REPAIR SHIPS AND TENDERS

Source: Rear Admiral D. H. Jackson, USN, CINCPACFLT Maintenance Officer, Interview held at Pearl Harbor, Hawaii, 2-4 December 1969.

Mobile Riverine Forces. Two additional landing craft repair ships, the USS SATYR (ARL-28) and USS SPHINX (ARL-24) were subsequently activated and deployed in-country, each supporting a River Assault Squadron of the Riverine Force.

(3) Floating Drydocks

(a) The floating drydocks located at Subic Bay, Guam, and later in-country were a part of Pacific Fleet Mobile Logistic Support Force manned by military personnel. Inspections early in FY 66 had shown the floating drydocks to be deficient in their readiness for independent service. An improvement program was initiated to make the drydocks self-sufficient and capable of operating independently as an advanced base in forward areas off Vietnam, or in the Indian Ocean for battle damage repair. Throughout the Vietnam buildup the material readiness of floating drydocks at Subic Bay and Guam continued to improve. Continued emphasis on drydock readiness and allocation of sufficient resources are necessary to ensure completion of this task.

(b) With the in-country buildup, two small auxiliary floating drydocks (AFDLs) were activated and positioned at Da Nang and Cam Ranh Bay. An 18,000-ton auxiliary drydock was activated and modified to provide capabilities for docking ships with the latest sonar equipment and nuclear submarines at Subic Bay. Because of the delay in the military construction program, the drydock was delayed at Guam for approximately one year, awaiting the completion of construction of the mooring and approach pier at Subic Bay. This new medium austere drydock was authorized on the premise that it would be manned by Civil Service personnel, which was a departure from the military manning concept of floating drydock readiness.

(c) Table 19 summarizes the plant and drydock facilities which were available in WESTPAC during the Vietnam era.[13] The value of the floating drydocks was demonstrated by the heavy usage of their services which could not have otherwise been provided to the fleet in SE Asia. Figure 11 provides a summary of the number of ships and craft drydocked at Subic Bay and Guam in floating drydocks during the Vietnam era.[14]

(d) One of the most critical deficiencies was the lack of drydocks capable of accommodating an attack aircraft carrier and other large ships. Fortunately the use of drydocks in Japan was permitted for nonnuclear ships. Excellent drydock facilities also existed at Singapore. The nearest United States shipyard capable of drydocking an attack carrier was at Pearl Harbor, Hawaii, 5,600 miles from SE Asia. At present, a 100,000-ton commercial floating drydock is in the Navy FY 72 shipbuilding program for positioning in United States Territory in Guam.[15]

(4) Other Types of Mobile Repair Support. Throughout the Vietnam buildup, the Service Force Mobile Technical Units added to the Seventh Fleet material readiness through repairs during on-the-job training as well as by providing civilian contract engineers who were knowledgeable in the newer, more complex electronics, such as fire control and missile systems. Mobile communications repair support also provided to ships of the Seventh Fleet by two major communication relay ships, USS ANNAPOLIS and USS ARLINGTON, through the use of equipment pools of selected communications equipment. Seventh Fleet ships turned in failed items which were repaired by the ANNAPOLIS and ARLINGTON ship personnel. This was an extraordinary use of personnel, since this was not a mission requirement for these ships.

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13 Joint Logistics Review Board, Briefing by CINCPACFLT Maintenance Officer, subject: Pacific Fleet Ship Maintenance, 23 July 1969.

14 Naval Ship Systems Command, Management Office, Western Pacific Area, Letter, subject: WESTPAC Drydocking Statistics FY 64-69, 12 December 1969.

15 Joint Chiefs of Staff, Assistant Director for JCS Matters, Logistic Plans Division, Memorandum, subject: Drydock, Guam, 9 September 1969.

TABLE 19

SHIP REPAIR FACILITIES/SHIP REPAIR DEPARTMENT
PLANT AND FACILITIES

PLANT AND FACILITY	SUBIC BAY	YOKOSUKA	GUAM	SASEBO
Land Acreage	40	72	105	20
Drydocks	AFDL-10, AFDL-11, ARD-22, AFDM-5 AFDM-6	6 Graving Docks	AFDL-21, ARD-29, AFDM-8	3 Graving Docks
Size of Largest Drydock	AFDM-6 552 ft X 97 ft (18,000-Ton Lift)	Drydock No. 6 1,099 ft X 168 ft	AFDM-8 552 ft X 97 ft (18,000-Ton Lift)	1,214 ft X 243 ft
Largest USN Ship Accommodated	Heavy Cruiser	Attack Aircraft Carrier	Heavy Cruiser	Attack Aircraft Carrier (to 42,000 tons)
Wharf Length - Water Depth	2,763 ft - 20 ft 1,720 ft - 30 ft 2,022 ft - 40 ft	400 ft - 18 ft 330 ft - 26 ft 2,800 ft - 30-40 ft 4,140 ft - 40 ft	3,301 ft - 35 ft 1,000 ft - 35 ft	None
Maximum Weight-Lifting Capacity	Two 100-ton floating cranes	One 300-ton hammerhead crane	One 125-ton floating crane	Two 20-ton hammerhead cranes
Cold Iron Berthing	Electricity Steam Air	Electricity Steam Air	Electricity Steam Air	None, except in drydock

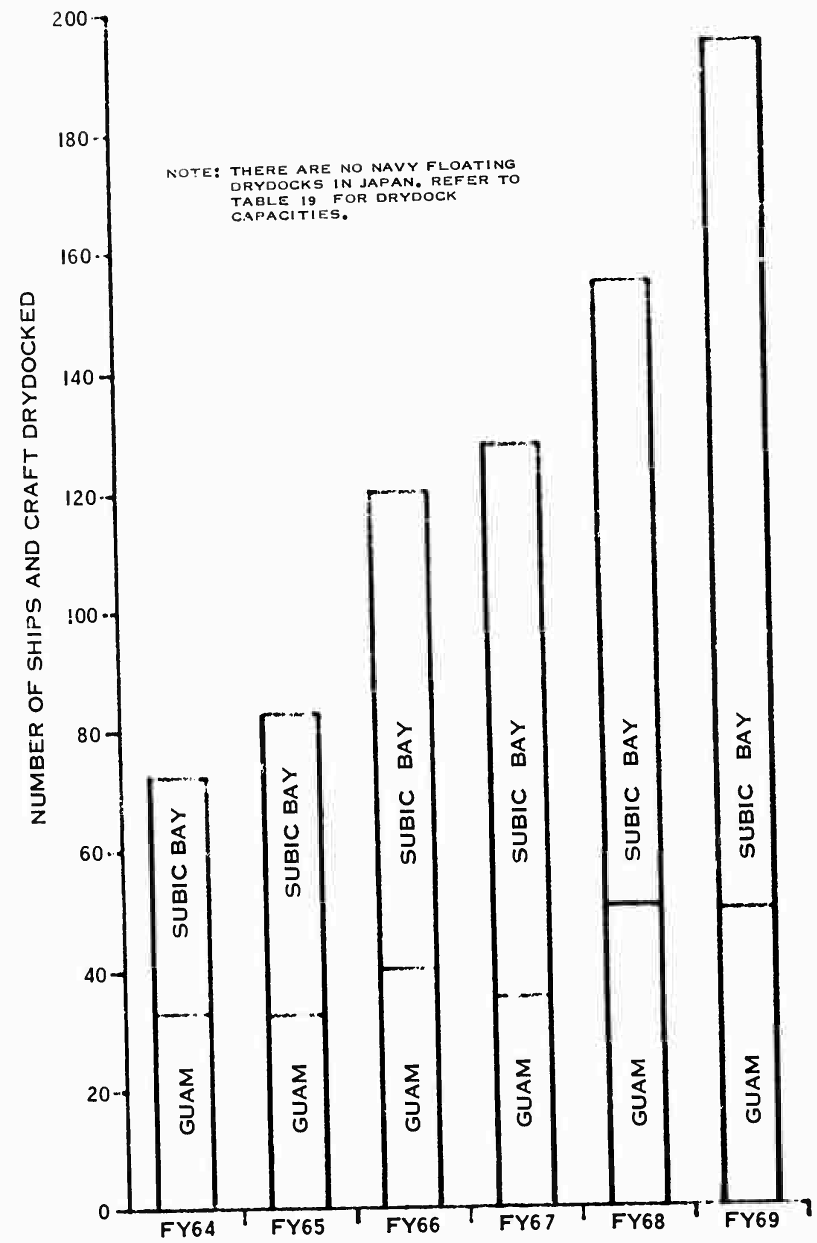

FIGURE 11. NUMBER OF SHIPS AND CRAFT DRYDOCKED IN FLOATING DRYDOCKS AT U.S. NAVAL SHIP REPAIR FACILITIES, SUBIC BAY AND GUAM

(5) Steps to Increase Capacity at Ship Repair Facility, Subic Bay

(a) The U.S. Navy Ship Repair Facility, Subic Bay, in the Republic of the Philippines, was about 800 miles from the coast of Vietnam. The steaming distance to Subic Bay from a ship deployed off Vietnam required less than half the time required to reach any other comparable repair activity. Early in 1965 it was apparent that drastic increases in manpower, range of skills, and facilities would be required to provide the requisite capabilities to keep up with the projected demand of SE Asia operations.

(b) The Ship Repair Facility did not have an adequate military construction program which reflected contingency planning for growth. The most critical construction deficiency was the lack of available pier space as evidenced by loading factors of 2.6 to 4 ships per berth. Emergency military construction projects were submitted and concurred in by all levels of the Navy Department for a new repair pier, harbor dredging, a new ships berthing bulkhead with portal cranes, an additional medium floating drydock (AFDM), and renovation and expansion of eighteen shops.

(c) Funds were provided for the dredging, the ship berthing bulkhead, a new electrical and electronic shop, renovation and shipment of two portal cranes from New York Naval Shipyard, and the additional drydock. At the Department of Defense level, the Navy's military construction priorities for the Ship Repair Facility, Subic Bay, shops were changed and others substituted. The Department of Defense submission was approved and funds authorized. Despite the possibility of loss of the approved fund, CINCPACFLT initiated a reprogramming action to restore the deleted projects. This decision resulted in numerous resubmissions of justification and many visits to Subic Bay by personnel and committees from the Navy Department, Department of Defense, and Congress. Approval to reprogram within the amount originally authorized by Congress was granted two years later. As a result the increased shop capacity needed early in the buildup was not ready until 1969 and 1970, after the peak of Vietnam buildup had passed. The application of peacetime military construction submission, review, and approval procedures for activities in direct support of combat forces in SE Asia was a major weakness.

(d) The inability to renovate and expand the shops had serious consequences. The facilities, particularly in the boiler shop, sheetmetal shop, and internal combustion engine repair shop, became the limiting factor on the numbers of employees who could work efficiently in the spaces and the amount of work in these trades the facility could handle. Two 12-hour shifts were common in most shops and the average employee work week climbed from 49 hours per week in early 1965 to 65 hours in 1968. Most employees worked 13 out of 14 days; the one day off was mandatory for employee health and welfare.

(e) The indigenous work force expanded from 1,800 personnel in 1965 to 6,000 in 1969. Although the labor pool for unskilled labor was limitless, the rate of augmentation was kept in check by the degree of training and supervision available. Numerous ceiling increases were granted as soon as the facility indicated it could profitably use additional people. Prior to the buildup, fleet work made up a low percentage of the workload with the disadvantage that the Filipinos often were not familiar with equipments in the newer ships. Training became a major effort and an ongoing 4-year apprentice program which graduated less than 25 Filipino employees in 1965 escalated to an induction rate of over 200 Filipinos in 1966 and each year thereafter. Indigenous journeyman level personnel were provided specialized training on repair of all ship equipments, and many were sent for training to U.S. naval shipyards and factories. Trained high quality naval officers were required along with an upgrading of civilian supervisory personnel. At the height of the buildup the activity had less than 20 naval officers, over 100 United States civil service employees, and 6,000 Filipino employees.[16]

(f) Difficulty was experienced in obtaining high quality civil service employees because of several factors. Inadequate on-base housing was the major deterrent for acceptance of employment. The wait for on-base housing was as long as 20 months and the living conditions in the local economy were extremely poor. Additionally, a number of inequitable civil service employment regulations and procedures discouraged many from the acceptance of employment at a time when the activity needed the best talent available.[17] Three examples are:

1. The wages of civil service "blue collar" supervisors at Subic Bay were established as an average of the wages paid throughout the United States. Most employees

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[16] Joint Logistics Review Board, Briefing by Commanding Officer, U.S. Naval Ship Repair Facility, Subic Bay, subject: Facility Operation, 11 September 1969.

[17] United States Civil Service Commission, San Francisco Region, Letter, subject: Review of Civilian Personnel Management at Naval Ship Repair Facility, Subic Bay, 12 August 1969.

were recruited from the west coast naval shipyards which had higher labor rates than east coast shipyards. Consequently a west coast employee received a decrease in his basic hourly rate when he accepted employment at Subic Bay. It was not uncommon for Subic Bay personnel to be in higher supervisory positions and receive less hourly wages than at their home shipyard. This had (and continues to have) a major impact on civilian employee morale.

2. Long delays in implementing wage increases after they had been implemented in the U.S. Naval shipyards.

3. Promotions received overseas were not recognized in the return rights placement program. Employees had no assurance or security in the retention of their promotion when they returned to the U.S. and were guaranteed employment only in the grade they previously held before going overseas. This provided little incentive for high quality employees to accept overseas employment for professional growth.

(g) Figure 12 provides a breakdown of the Ship Repair Facility, Subic Bay, productive workload from FY 65 to FY 69.[18] The Seventh fleet workload escalation resulted from a combination of peak port loading, and an increase in major and emergency repairs. The non-Seventh Fleet work would also have had a more significant effect if it had not been forehandedly diverted. By January 1966, Military Assistance Program ship overhauls had been diverted to Guam from Subic Bay, a shift which also had beneficial effects in helping stem the flow of gold. Overhauls and repairs to service craft were also reassigned elsewhere. Secondly, the Ship Repair Facility, Subic Bay, was granted approval to establish a new task for local contracting of work in the Manila area which provided needed flexibility in overall workload management. As the Vietnam buildup progressed the workload increased in scope and complexity. The production workload at Subic Bay reached a peak of about 1.25 million man-days in 1969.

(6) Effect of Southeast Asia Buildup at Ship Repair Facility, Guam

(a) Guam, in its strategic position at the center of 1,500 mile circle which touches Japan, Okinawa, the Philippines, and Australia and as the westernmost U.S. Naval Base on U.S. territory, attained new importance as the concentration of military power shifted toward SE Asia. In peacetime, costs, the deficiencies with regard to rest and recreation and other factors tended to channel ship repair work elsewhere. Employment at the Ship Repair Facility increased from a little over 700 in early 1965 to about 2,500 in 1968, which included civil service personnel from the United States, local hires, and Filipino national indirect hires.[19] The need for this increased work force resulted from the steady stream of Military Assistance Program ships rescheduled to Guam in lieu of Subic Bay and Yokosuka and the accelerated need for service craft maintenance in SE Asia.

(b) The buildup in the work force was accompanied by an improvement in the activity's technical capabilities; by June 1966 the new shop buildings which replace those destroyed in typhoon KAREN in 1962 were ready for occupancy. Additionally, Guam and Subic Bay benefited from excess tools made available from the closing of New York Naval Shipyard. In February 1967, Guam was designated as a tank landing ship (LST) Main Engine Rehabilitation and Modification Activity. This was based on the increased tank landing ship population in the Pacific, the improved internal combustion engine repair facility at Guam, and the need for a Government depot capability to modify tank landing ship engines. (The only other capability existed in a commercial firm which was subject to strikes, contractual delays, etc.) In FY 67, planning was initiated for the ultimate increase of facilities at the Ship Repair Facility, Guam, to accommodate a work force of 3,000 men when required.[20]

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[18] Joint Logistics Review Board, Briefing by Commanding Officer, U.S. Naval Ship Repair Facility, Subic Bay, subject: Facility Operations, 11 September 1969.
[19] Operations of Service Force, U.S. Pacific Fleet, Fiscal Year 1967, 1 September 1968, pp. 11-20.
[20] Operations of Service Force, U.S. Pacific Fleet, Fiscal Year 1967, 11 July 1967, pp. 11-14.

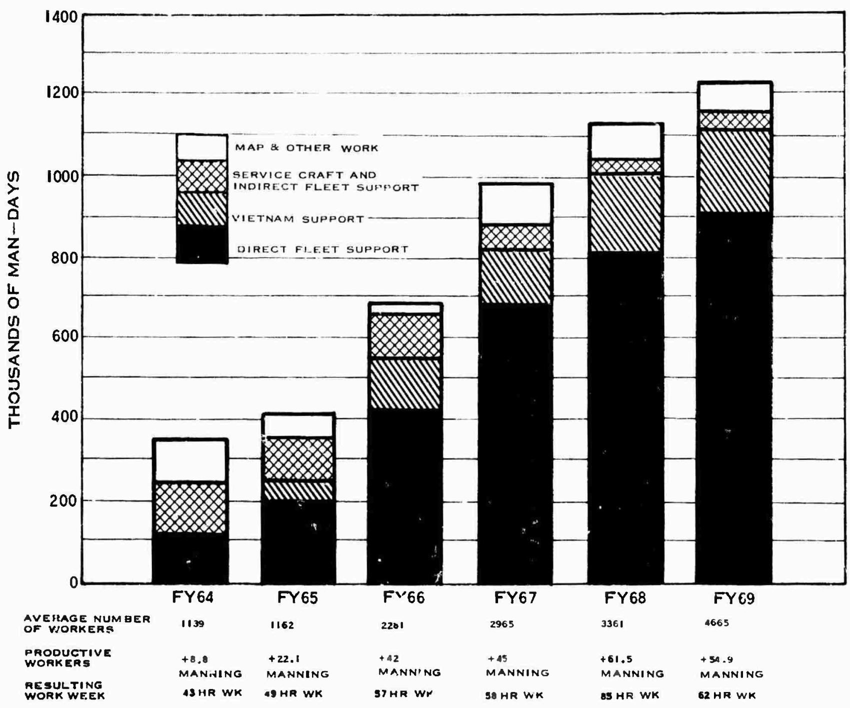

FIGURE 12. WORKLOAD DISTRIBUTION AT
U.S. NAVAL SHIP REPAIR FACILITY, SUBIC BAY

(c) Approximately 60 percent of the effort at Guam in FY 68 was directed to Seventh Fleet availabilities. Due to the distance from the SE Asia area of operations, the Ship Repair Facility, Guam, like Yokosuka, was generally assigned ship availabilities of longer duration in order to compensate for the increased transit times involved. Direct Vietnam support was provided by assembly and delivery of pontoons, and battle damage repairs to two landing ship tanks.

(7) Effect of Southeast Asia Buildup at Ship Repair Facility, Yokosuka, and Fleet Activities, Sasebo

(a) Industrial facilities at the U.S. Naval Ship Repair Facility, Yokosuka, Japan, approximated those of a U.S. naval shipyard, including the only capability in WESTPAC for drydocking an attack aircraft carrier and certain other large ships. This Facility had been improved and, at the start of the Vietnam buildup, was the largest and most capable repair facility in WESTPAC. No facility changes were necessary to handle the increased variety of work assigned. It employed a total of 2,437 Japanese nationals; however, an increase of Japanese personnel of any magnitude was unlikely. The reputation of the Yokosuka Ship Repair Facility among other United States Government employees was severely damaged by a 1965 reduction-in-force engendered by economy requirements. The Japanese employer becomes more benevolent in times of stress and does not allow a reduction-in-force to occur.

(b) The greatest impact of the SE Asia buildup at the Ship Repair Facility, Yokosuka, was in the area of contract work. Throughout the Vietnam buildup, the work force at Yokosuka remained constant at about 2,500 Japanese nationals. The Ship Repair Facility with its proximity to major Japanese industrial resources and consequent ability to subcontract to local firms displayed an enviable ability to adjust to unplanned work and workload surges. The responsiveness and labor pool for contract work provided by Japanese industry enabled the Ship Repair Facility to adjust to every emergency.

(c) Due to the distance from Vietnam, longer availabilities which averaged about 12 to 14 days (compared with 6 days at Subic Bay) were assigned in order to compensate for the increased transit time and permit greater in-depth repairs. Work on Military Assistance Program ships, which comprised a large segment of the FY 66 workload, was virtually all transferred to Guam. By issuing contracts to local firms, the Facility's capability was increased an average of 15 percent in FY 67, and 20 percent the following year.[21] This flexibility ensured that the material maintenance needs of the fleet were met, while a relatively constant in-house workload was maintained. As the only activity in WESTPAC with adequate capability for drydocking major ships, Yokosuka accomplished propeller repairs and replacements on two aircraft carriers and a combat stores ship in addition to over 100 other ships in 1967 and 1968.[22] The combined number of ships drydocked at Yokosuka and Sasebo are depicted in Figure 13.

(d) The personnel strength at the Ship Repair Facility, Sasebo, did not exceed 500 Japanese nationals. However, these figures do not indicate its larger productive capacity as more contract work was handled here than any other repair activity in WESTPAC. Farm-out work comprised 67 percent of Sasebo's total productive workload in FY 68.[23] With the Vietnam buildup, the Seventh Fleet workload continued to expand, with direct Vietnam support accounting for most of the remaining capability.

(8) Expanded Use of Commercial Ship Repair Facilities in Southeast Asia

(a) The increased workload in WESTPAC brought about a marked increase in the use of commercial ship repair facilities in Japan and the Philippines. Accomplishment of depot level commercial ship repair and overhaul was accomplished in two ways: first, by awarding a contract making the ship available to the contractor, normally at his plant, where he was responsible for satisfying the provisions of the contract specifications; and second, by augmenting the Ship Repair Facility's regular work force with contract labor for specified periods of time. As in the United States, the provisions of the Armed Services Procurement Regulations served as the basis for contracting commercial ship repair and overhaul services in the Pacific. This was done by contracting officers attached to WESTPAC U.S. Naval Supply Depots, with technical assistance and contract administration the responsibility of the Ship Repair Facility.

(b) Only depot-level naval ship repair work was contracted. Organizational and intermediate level maintenance was performed entirely by military personnel in the Pacific and in-country. With exception of Military Sea Transport ships, no Navy commercial ship repair work was accomplished in the Philippines prior to the Vietnam buildup. The dollar value of depot level contracting (both farm-out and farm-in) for Navy ship repair and overhaul in SE Asia during the Vietnam era is shown in Table 20.[24]

(C) In 1968, the Secretary of Defense authorized the use of commercial ship repair facilities at Singapore. The program was first under direct supervision of Commander, Service Group Three, and was later transferred to the Commanding Officer, Ship Repair Facility, Subic Bay. A Ship Repair Office was established with contracting services provided by the

[21] Operations of Service Force, U.S. Pacific Fleet, Fiscal Year 1968, 1 September 1968, pp. 11-14.
[22] U.S. Navy Ship Repair Facility, Yokosuka, Operations and Facilities Information Book, 18 September 1969, Data provided by Naval Ship System Command Management Office, Western Pacific (Code 70M3.4.), 4 December 1969.
[23] Operations of Service Force, U.S. Pacific Fleet, Fiscal Year 1968, 1 September 1968, pp. 11-26.
[24] Naval Ship Systems Command Management Office, Western Pacific Area, Letter, subject: WESTPAC Farm-In/Farm-Out Statistics, Fiscal Year 1969, 15 October 1969.

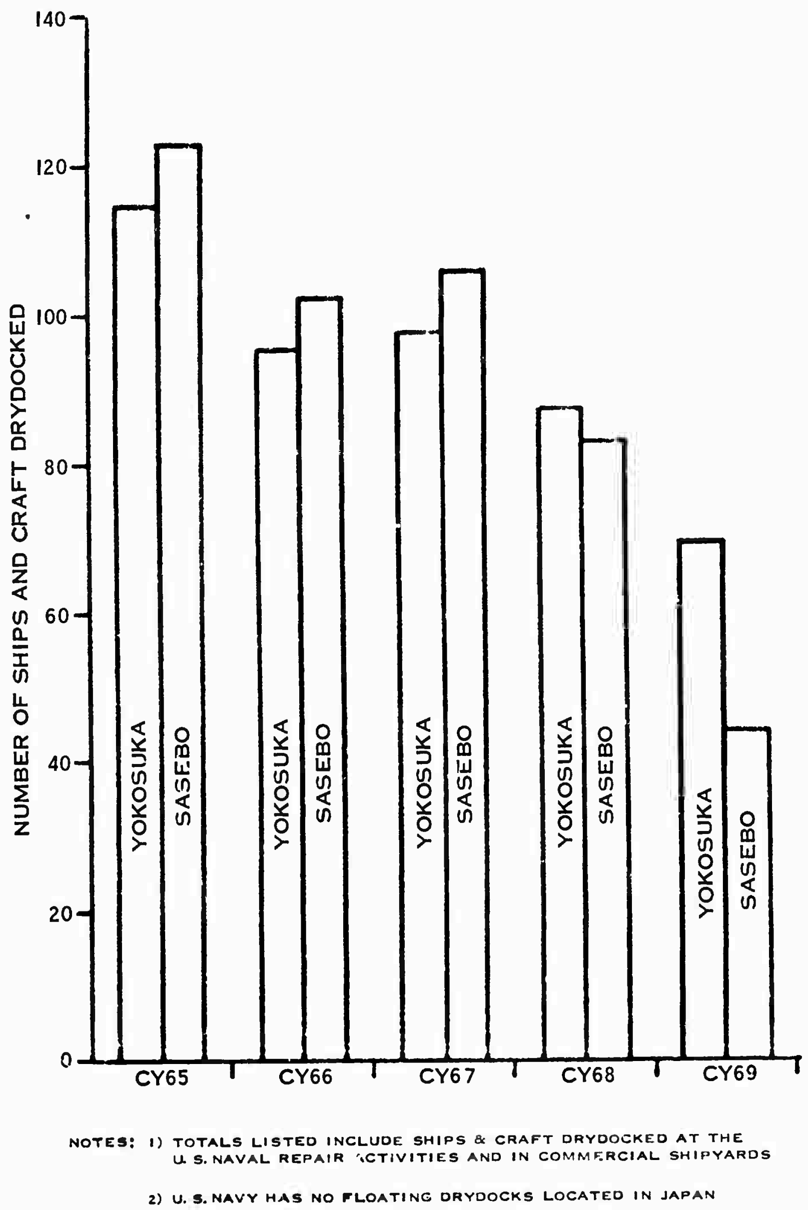

FIGURE 13. U.S. NAVY SHIPS AND CRAFT DRYDOCKED IN JAPAN

Naval Supply Depot, Subic Bay, on site in Singapore. Master Ship Repair contracts were held with a number of local Singapore commercial ship repair activities. The former British naval drydock and industrial facilities were transferred to the Government of Singapore and were available to U.S. Navy contract work. This dockyard was a major shipyard which offered facilities comparable to those existing at the Pearl Harbor Naval Shipyard.

(d) In FY 67, the Army requested Navy assistance in contracting for repair and overhaul of Army craft stationed in Vietnam. Initially U.S. Naval Station, Sangley Point, in the Philippines, assumed Army marine watercraft repair and overhaul contracting responsibilities for the Philippines, Singapore, and Taiwan. By 1968 this contracting arrangement had become unstable because of the growth of Army requirements and lack of a formal interservice support agreement. U.S. Naval Supply Depot, Yokosuka, assumed Army boat repair contracting functions in Singapore in June 1968. In August 1968, U.S. Naval Station, Sangley Point, transferred boat repair contracting in the Philippines to U.S. Naval Supply Depot, Subic Bay. During the same month, the Naval Supply Depot, Yokosuka, assumed boat repair contracting on Taiwan from the Army. In January 1969, the responsibility for Army boat repair contracting in Singapore was transferred to the Naval Supply Depot, Subic Bay. At each of the Naval Supply Depots contracting service to the Army was provided through interservice support agreements. The Army prepared the contract technical specifications, provided all the necessary repair parts and material, and after award administered the contract with Army personnel.

TABLE 20

DEPOT LEVEL FARM-OUT AND FARM-IN LABOR CONTRACTING
FOR NAVAL SHIP REPAIR AND OVERHAUL—WESTPAC
(Thousands of Dollars)

Farm-Out

Depot	FY 65	FY 66	FY 67	FY 68	FY 69
Yokosuka	50	1,773	2,596	1,526	5,180
Sasebo	634	2,671	3,736	3,790	3,426
Subic Bay		321	242	503	306
Singapore				116*	1,402

Farm-In

	FY 65	FY 66	FY 67	FY 68	FY 69
Yokosuka	0	232	364	300	311
Subic Bay	0	0	0	133	499
Guam**	2,424	4,935	5,388	7,435	5,921
Da Nang***					710

*Two-month period only in FY 68.
**Figures represent cost of employment of Filipino national contract labor at U.S. Naval Ship Repair Facility, Guam. Commander, Naval Forces, Marianas, Letter, Serial 666 of 19 March 1969 to CINCPACFLT provided a projected plan for displacement of nonimmigrant alien journeymen to less than 50 at SRF Guam by 1 July 1974.
***Philco-Ford contract labor for U.S. Navy Small Craft Repair Facility, Da Nang.

(e) In December 1968, OSD recommended that the Department of the Navy be designated as single Service depot level maintenance and supply support manager for all marine watercraft and equipment in the Pacific Ocean area.[25] This was not concurred in by both the Army and Navy. In August 1969, the U.S. Army, Pacific, requested termination of Navy interservice support of ship maintenance contracting service and assumed this responsibility in-house.[26] Figure 14 provides the dollar value by location for Navy contracting for Army marine maintenance.[27]

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[25] Assistant Secretary of Defense (Installations and Logistics) Memorandum; Report of Survey of Contract Services in the Pacific Ocean Area (13 October-19 November 1968.
[26] Department of the Army, Letter, Procurement of Marine Maintenance Services, 19 August 1969.
[27] Joint Logistics Review Board, Briefing by CINCPACFLT Maintenance Officer, Pacific Fleet Maintenance, 23 July 1969.

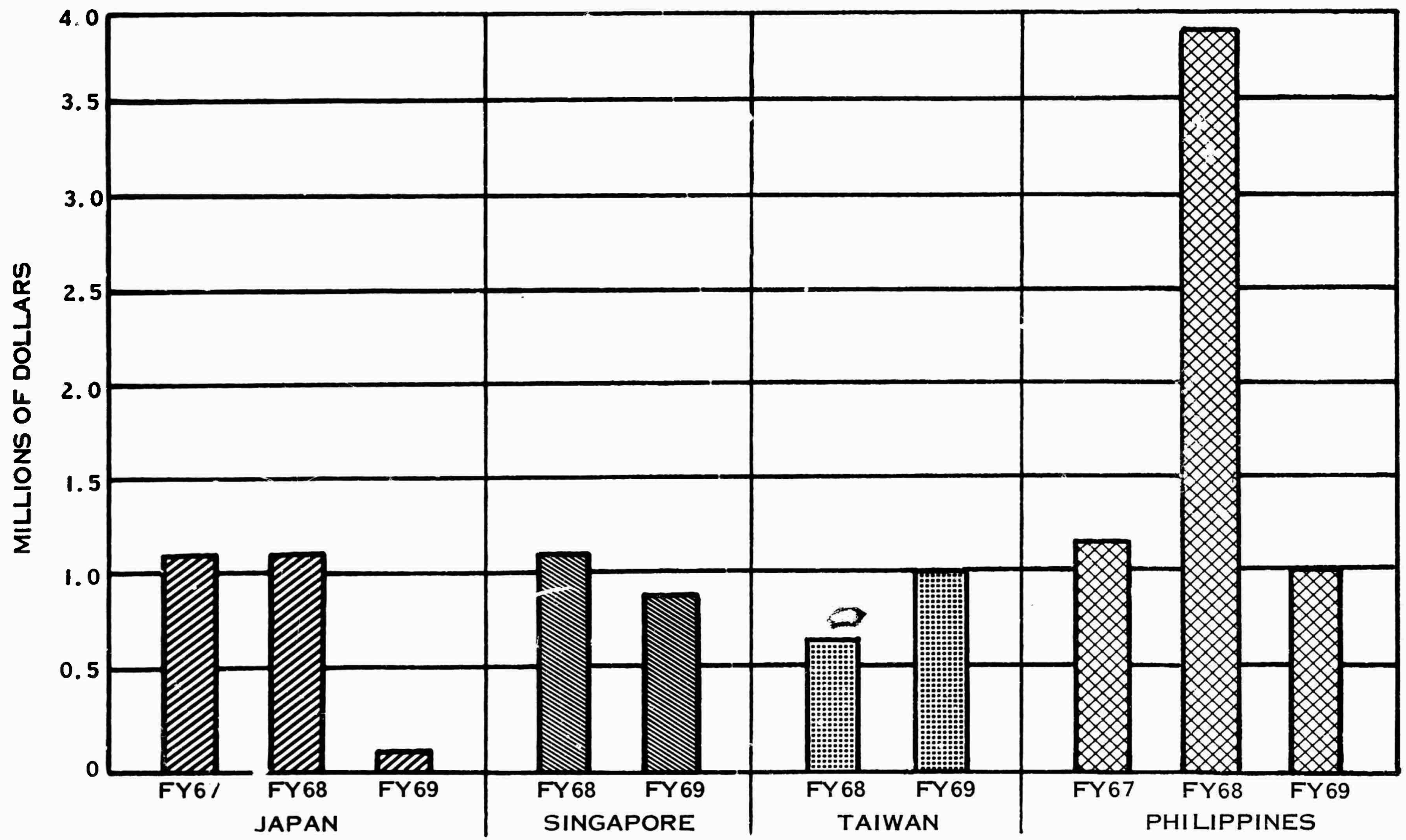

FIGURE 14. NAVY CONTRACTING FOR ARMY WATERCRAFT MAINTENANCE BY LOCATION IN SOUTHEAST ASIA

Source: Joint Logistics Review Board, Briefing by CINCPACFLT Maintenance Officer, subject: Pacific Fleet Maintenance, 23 July 1969.

(9) Military Assistance Program Ship Repair and Overhaul Support

(a) The Vietnam buildup had a major impact on the Military Assistance Program (MAP) overhaul program in shifting the overhaul and repair locations from Subic Bay and Yokosuka to Guam. In 1966 emphasis was placed upon the development of the Philippine Navy facilities at Cavite to comply with the concept of developing MAP in-country overhaul capabilities and to provide relief to the growing workload at the U.S. Naval Ship Repair Facility, Guam. With U.S. technical assistance the Philippine Navy accomplished their first in-country overhaul of a combatant ship. New shop and pier facilities were developed at Cavite, a 2,800-ton small auxiliary drydock was provided the Philippine Navy and additional fuel oil storage was provided from inactive and excess Navy service craft assets.

(b) In 1968, Commander, Service Force, recommended implementation of a credit system for ship repair work accomplished in foreign shipyards. This system involved U.S. dollars deposited in U.S. banks upon which the foreign Navy or private contractor drew funds for procurement of U.S. manufactured products for payment of services rendered.[28]

(c) Negotiations were underway with officials of the Government of the Philippines on carrying out the basic concept of this Credit System. It was anticipated that implementation in the Philippines could result in improving the U.S. balance of payments by $5 million to $10 million annually. This concept deserved continuing attention, but at the time of this writing had not been implemented.

(d) The major contribution to MAP by the U.S. Naval Ship Repair Facility, Yokosuka, was the activation and conversion of ships and craft which were later transferred to Vietnam and Thailand in 1966. Work on the Military Assistance Program which comprised a large segment of the FY 66 workload was virtually absent during the following years, as this type of work was transferred to the Naval Ship Repair Facility, Guam.

(10) Depot Level Support for Ships at Sea Off Vietnam. When the tempo of fleet operations began escalating, greater emphasis was placed on performing corrective maintenance to ships at sea because operational commitments could not release the ships without serious consequences. This was particularly true for the attack aircraft carriers, ammunition, and underway replenishment ships and fleet oilers. Depot level repair at sea required extremely well coordinated planning between the Seventh Fleet and the Repair Facility. The procedure normally involved carrier on-deck delivery and intraship transfers by helicopter or highline of men, material, and special tools. Once aboard the ship requiring repairs, the working conditions were often intolerable from heat or location. In FY 69 a total of 4,485 man-days of depot level team repair support was provided the Seventh Fleet by the Ship Repair Facility, Subic Bay.[29] This concept of corrective maintenance required the activity's best skilled personnel, who were often called upon to perform corrective maintenance to ships on the gun line off Vietnam and in-country. The Navy's responsive organic depot level civilian personnel in Southeast Asia have been a major strength during the Vietnam era.

(11) Summary

(a) Figure 15 summarizes the depot level maintenance performed by the Ship Repair Facilities on the Seventh Fleet and in-country ships and craft during the Vietnam era.[30] Table 21 summarizes the repair capabilities which were available in the Western Pacific Repair Activities 4 years after the Vietnam buildup began. The special capabilities were in addition to the normal shipyard capacity and had evolved as a direct response to particular Pacific Fleet and Vietnam requirements.[31]

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[28] Operations of Service Force, U.S. Pacific Fleet Fiscal Year 1968, 1 September 1968, pp. 10-12.
[29] Naval Ship Systems Command Management Office, Western Pacific, Letter, subject: Statistics on Number of Man-Days of Depot Level Support for Ships at SEA Off Vietnam, Fiscal Year 1965-69, 17 October 1969.
[30] Operations of the Service Force, U.S. Pacific Fleet Fiscal Year 1968, 1 September 1968, p. IV-93.
[31] Joint Logistics Review Board, Briefing by CINCPACFLT Maintenance Officer, Pacific Fleet Ship Maintenance, 23 July 1969.

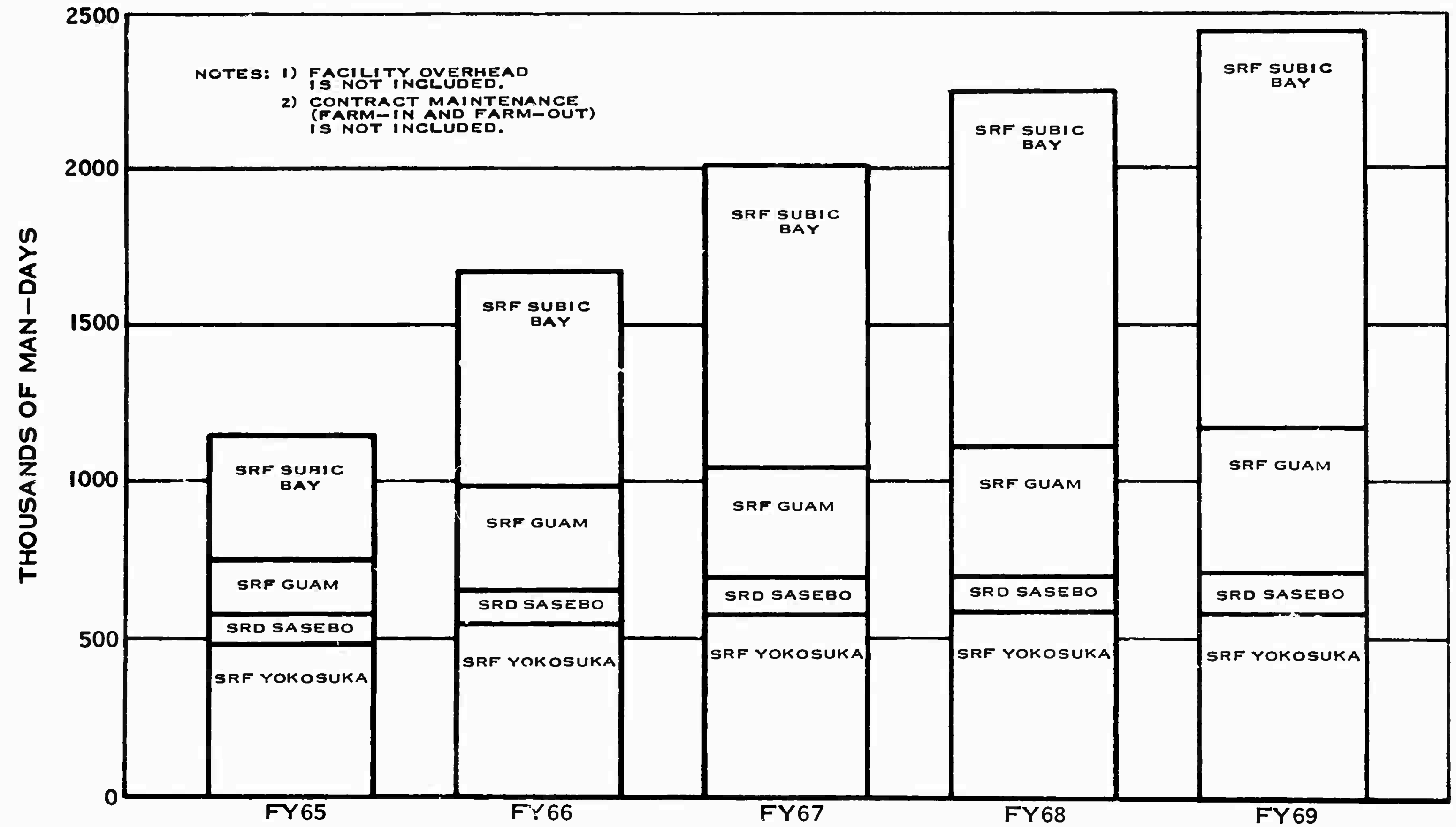

FIGURE 15. TOTAL PRODUCTIVE MAN-DAYS EXPENDED IN-HOUSE BY SERVICE FORCE SHIP REPAIR FACILITIES

Source: Mr. Tuk Wong, U.S. Naval Ships Systems Command, Management Office, Western Pacific, telephone interview, 6 April 1970.

TABLE 21

SHIP REPAIR FACILITIES/SHIP REPAIR DEPARTMENT SPECIAL CAPABILITIES

CAPABILITY	SUBIC BAY	YOKOSUKA	GUAM	SASEBO
Electronics Reference Standards Laboratory	X	X	X	X
Radiac Repair	X	X	X	
Diving and Salvage Services	X	X	X	X
Cryptographic Repair	X	X	X	
Guided Missile System Collimation	X	X		
Magnetometer Control Degaussing System	X			
Minesweep Cable Repair	X			
Underwater Acoustical Range			X	
Napier-Deltic Diesel Engine Overhaul	X			
Nonmagnetic Engine Overhaul	X		X	X
Gas Turbine Repair				X
Metal Binding & Cutting	Process plate 1 in. X 10 ft.	Shear plate 1/2 in. Bend up to 1 in. thickness	Shear plate 1/2 in. 1/2 in. X 10 ft. roll 1 in. shell plate	Process plate 1/2 in. X 6 ft.
Patrol Gunboat (PG) Overhaul		X	Operational by 1 January 1970	
Lube Oil Analysis	Operational by 1 January 1970		X	
Regunning 8 in. guns	X	X		
Probe Fueling Installation	X	X		X
SUBSAFE PROGRAM	Limited	Limited		

Source: Joint Logistics Review Board, Briefing, CINCPACFLT Maintenance Officer, Pacific Fleet Ship Maintenance, 23 July 1969.

(b) The age and condition of the fleet and contingency planning for ship battle damage resulted in the need for expansion of the WESTPAC Ship Repair Facilities and the deployment of more repair ships. During the Vietnam era, the amount of ship battle damage caused by direct enemy action has been minimal, whereas indirect battle damage caused by fires, groundings, and collisions has increased with the growth of the ship population and fleet operations. Because direct enemy battle damage to Seventh Fleet ships did not become a major workload consideration, the repair workload growth was the level of effort necessary to maintain the ships combat-ready. The amount of repair capability expansion in SE Asia would not have been as great, or perhaps necessary at all, except for the age and material condition of the fleet. Had battle damage repair become a major workload consideration, additional capacity sufficient to meet the need would have been required.

(c) Although each repair activity was faced with entirely different constraints on its ability to grow, the success that was attained testified to the inherent strength and flexibility of placing all WESTPAC Ship Repair Facilities, Naval Supply Depots, Repair Ships, and Tenders under one Command. Coupling the Ship Repair Facilities and the Supply Depots significantly enhanced WESTPAC maintenance responsiveness through tailored programs designed to identify material requirement and position material where it was needed. Untiring support was provided by the Naval Systems Command and Bureaus through responsive technical assistance and procurement of resources for the expanding repair capabilities. Particularly noteworthy was the technical assistance provided by the Naval Ship Systems Command Management Office, WESTPAC, an office charged with supporting COMSERVPAC.

d. Support of In-Country Navy Ships and Craft

(1) Market Time, Game Warden, and the Mobile Riverine Force

(a) Market Time bases were first established at An Thoi on Phu Quoc Island and at Da Nang in 1965 where the USS KRISHNA (ARL-38) provided repair support at An Thoi and the floating workshop (YR-71) provided the initial maintenance support at Da Nang. The USS TUTUILA (ARG-4) arrived at Cat Lo in October 1966, making that base a major overhaul station for Market Time and Game Warden equipment. Unfortunately, the completion of in-country Market Time and Game Warden facilities was hampered by various delays, primarily resulting from funding shortages and construction priorities. This necessitated use of the bases before they were ready. The facilities at Cam Ranh Bay were initially planned to accomplish depot level repair of PCF and WPB; however, this was subsequently changed to include intermediate level repair of mine-sweeping boats and patrol gunboats.

(b) In early 1966, shortly after Operation Game Warden was initiated, there existed a compelling need for planning, projecting and integrating maintenance facility requirements on a wide basis to encompass estimated expansion of requirements as well as programs then currently in the development stage. Except for Market Time, most programs had been conceived during the prior few months without benefit of comprehensive logistic planning. Of paramount concern was the need for integration of facilities at each base supporting more than one operation. All in-country facilities afloat and ashore were tailored to a specific base loading. This provided flexibility in the depth of repair performed on craft identified within the mission of the base; however, other families of craft were not supportable.[32] Figures 16 and 17 summarize the in-country growth of combat and service craft.

(c) LST 542 class ships were reactivated and modified to accomplish the river patrol support-ship mission. Considerable alterations were necessary to convert these LSTs as PBR mother ships. This included enlarging the cargo hatch, removing the crane and installing a boom for lifting the PBR, addition of a helicopter flight deck with appropriate reinforcements, lifting facilities and lighting for night flight operations, expansion of communications facilities and the combat information center, addition of JP5 fuel storage, and installation of rocket magazines.

(d) As Game Warden base buildup progressed, it was found that shore bases lacked the mobility required to meet the changing operational situations and afloat assets were used to establish new bases and augment existing bases. Certain bases were phased over to the Vietnamese Navy, or were disestablished, or reduced as it became apparent the base locations were no longer needed.

[32] Commander, Service Forces, Pacific Fleet Maintenance Office, Survey Report of Maintenance Support Requirements in Vietnam, 30 March-10 April 1966; trip report Maintenance Facilities Assistance Team Visit to Republic of South Vietnam, 22 May-3 June 1966.

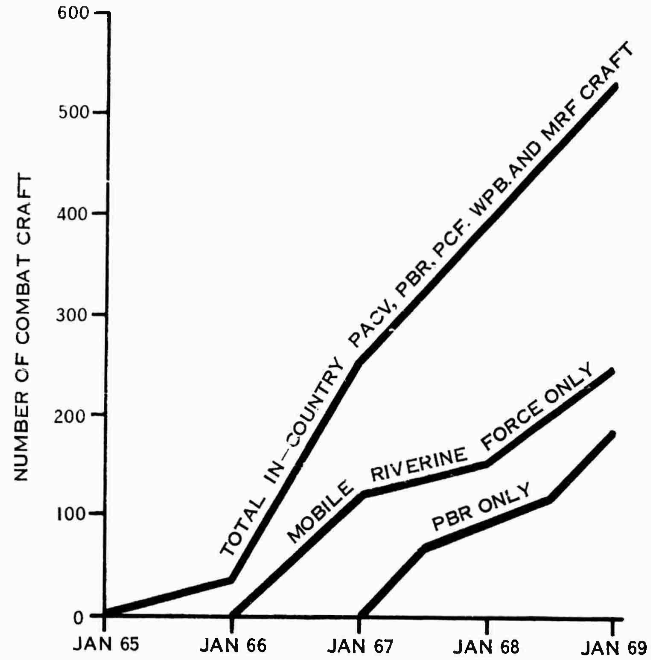

FIGURE 16. IN-COUNTRY COMBAT CRAFT GROWTH FOR MARKET TIME, GAME WARDEN, AND MOBILE RIVERINE FORCE

Source: Rear Admiral D. H. Jackson, USN, U.S. Pacific Fleet Maintenance Officer, Interview and data from CINCPACFLT files, 17 December 1969.

(e) In the I Corps, because of insufficient river depth, barge complex bases were successfully used for PBR support. For maintenance support, each PBR mobile base could hoist and accommodate two PBRs out of the water for repair, and each had a boat repair shop complete with the boat engine lift equipment and battery charging system. The first Mobile River Patrol Base was located at Tan My in I Corps under operational control of NSA, Da Nang Because of the success of this mobile repair concept, a second mobile base was established on the upper Mekong providing full support for 10 PBRs.

(f) The Mobile Riverine Force assault craft were repaired and maintained at different places. Joint Army and Navy depot level repairs to riverine warfare craft and boats were provided at the principal repair base at Dong Tam. Organizational maintenance was the responsibility of the boat's crew. Intermediate maintenance, including main engine replacement, battle damage repairs and repairs to the underwater hull, was done by the landing craft repair ship (ARL). By using an "A" frame, the ARL could lift riverine assault craft onto an Ammi pontoon equipped with blocks. The ARL had about 4100 line items of repair parts for riverine craft. At 6-month intervals, each craft was sent to the repair and berthing barge (YRBM) at Dong Tam for depot level repair where the craft's engines were removed and replaced with rebuilt engines. The removed engines were sent to the ARL for rebuilding and dynamometer testing before being placed in storage or returned to the YRBM for a future overhaul.

(g) The evolution of the joint Army-Navy operations placed operating craft at advanced bases with only organizational maintenance capabilities and also staged mixtures of craft at bases afloat and ashore which were designed to support only one family of craft. To

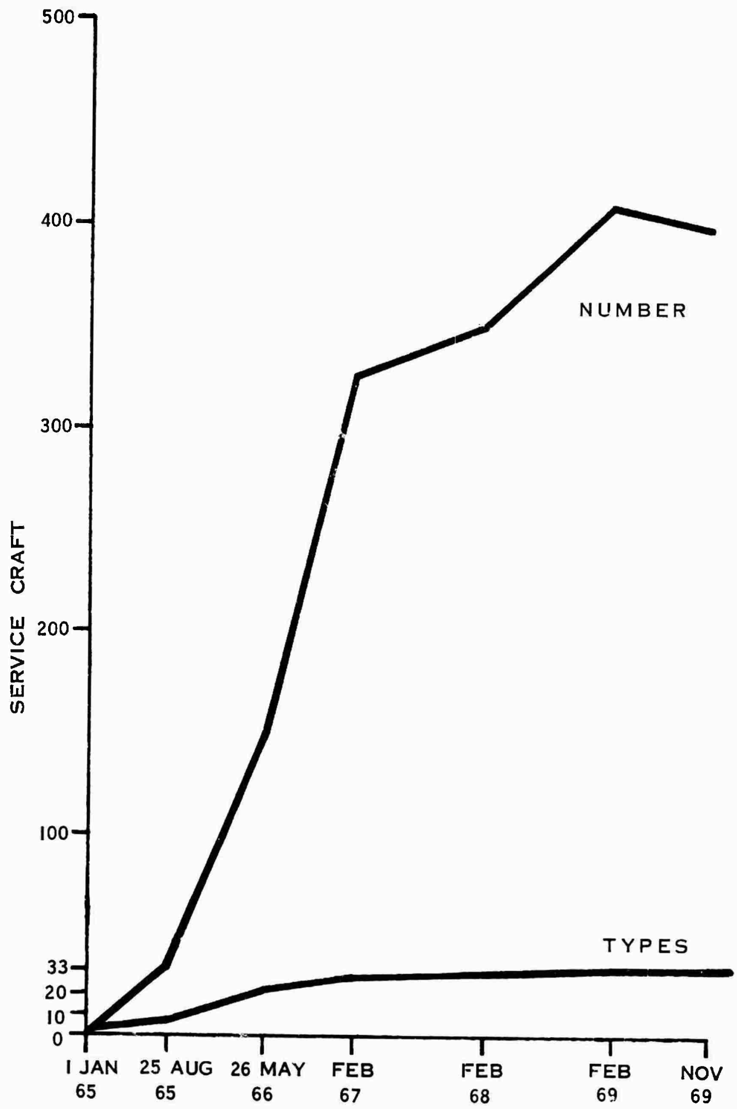

FIGURE 17. GROWTH IN NUMBER AND TYPES OF SERVICE CRAFT IN-COUNTRY (NSA, DA NANG, AND SAIGON)

Source: Rear Admiral D. H. Jackson, USN, U.S. Pacific Fleet Maintenance Officer, Interview and data from CINCPACFLT files on NAVSUPPACTS, Da Nang and Saigon, 4 December 1969.

enhance responsiveness a central maintenance concept was developed by Naval Support Activity, Saigon. This represented a departure from the requirement for the craft and boat crew who initiated the repair requests to be responsible for the processing and monitoring of intermediate and depot level repairs to their craft. A boat and craft exchange program was initiated, comparable to the Army maintenance float system. This program was administered at Nha Be by Naval Support Activity, Saigon, and successfully relieved the small operational units which were overburdened from the rapid buildup.[33]

(h) As a result of the success of the mobile riverine force concept, two more propelled berthing ships (APB) and three landing craft repair ships (ARL) were activated in the U.S. and deployed in-country. They provided support for a larger force and with greater mobility.

(2) Naval Support Activity, Saigon

(a) When commissioned NAVSUPPACT, Saigon, had five minimal primitive bases operational. With the establishment of the Mobile Riverine Force, Naval Support Activity, Saigon was tasked through Commander Service Force, U.S. Pacific Fleet, to provide logistic support to the Naval element of the mobile riverine force, which in turn supported the entire force. This included resupply of the Mobile Riverine Base. NSA, Saigon, established a detachment at Dong Tam for maintenance support of the Navy craft in the mobile force.

(b) Providing Navy-peculiar items, primarily boat repair parts, was a continuing problem throughout the Vietnam era. When the buildup commenced, Naval Supply Depot, Subic Bay, was charged with responsibility of providing boat spares. Because of the large numbers of repair parts required in-country, action was taken to transfer boat repair stocks from Subic to Saigon. This improved the in-country supply support through continual review of load lists against usage data to identify new requirements, and improved screening and rapid identification of urgent requirements.

(c) Throughout the Vietnam era, the U.S. Navy provided technical boat building and repair assistance to the Saigon Vietnamese Naval Shipyard through naval advisors. Early in the buildup COMSERVPAC, assisted by the U.S. Naval Ships System Command, conducted extensive surveys at the shipyard to recommend improved management procedures and means to increase production.

(3) Advanced Base Functional Component System. One of the most useful tools in regard to maintenance of boats and craft in Vietnam was the Advanced Base Functional Component System (ABFC). This was used in the planning, manning and equipping of the Naval Support Activity, Da Nang, and repair facilities in support of Market Time and Game Warden. The ABFC System was developed during World War II to establish Navy advanced bases with personnel, facilities, equipment, material, vehicles, craft, and 30 to 90 day consumables. Reduced funds after World War II permitted little more than maintaining the components. Commencing with the buildup at Da Nang, Advanced Based Functional, Small Boat Repair Components (component identification E-8) were established in-country.[34] A total of 15 small boat repair components, at 11 sites in II, III, and IV Corps areas, were established for combat craft maintenance in addition to the sites at Da Nang and Chu Lai. The availability of the ABFCs for boat and craft repair work and other logistic support significantly reduced the time required for establishing operational repair facilities at remote locations. The fact that some equipment had been in storage for long periods of time and was obsolete, and not all the material and personnel were available, was but a minor irritation when balanced against the overall good of the system.[35] Much valuable experience was gained and the Vietnam conflict stressed the potential of the system and the

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[33] Joint Logistics Review Board, Briefing by NSA, Saigon, Repair Officer, Capt R. S. Howell, USN, subject: Surface Navy Maintenance, 14 September 1969.
[34] U.S. Navy, OPNAVINST P 4040.22c, p. 112.
[35] U.S. Navy, OPNAV, Southeast Asia Combat Analysis Group Study, Advanced Base Functional Components—Problems Associated with Their Use in the Republic of Vietnam, 18 August 1969.

concept. The Advanced Base Functional Components (ABFC) concept was a major maintenance support strength which emerged during the Vietnam era.

(4) In-Country Nonpropelled Craft Mobile Support Base

(a) The Vietnam conflict highlighted the outstanding maintenance and support contribution made by nonpropelled barges used in-country as mobile bases. The concept of mobile barge maintenance support was used during World War II, but in the peacetime economy after the war the barges were inactivated or scrapped. In 1965, the in-country requirements for mobile shallow craft maintenance support craft began emerging. What was needed in the Delta and along the coast was working space, storage space, lifting capacity, fuel capacity, berthing and messing and communication facilities suitable for the operating forces. Two repair barges, designated YR, were the first activated and each required substantial renovation, replacement of obsolete equipment, and rearrangement of the repair spaces for in-country use. These craft served their purposes well, but the converted covered barges (YFNB) were the star performers because of their larger size. At the start of the Vietnam buildup, eight YFNBs were available among the inactive service craft assets at Subic. COMSERVPAC obtained four barges for NSA, Da Nang, which were modified for lighterage. The other four craft were obtained for in-country Game Warden support. Because of the urgent need, two in an "as is" condition went directly in-country with ABFC equipment and two were towed to Japan for conversion to a new type of repair and berthing barge (YRBM). Later at Nha Be, the first two were converted to YRBM by in-country forces, a remarkable feat considering the resources available and the scope of work done.

(b) The nonpropelled barges had more space for support activities than a ship of comparable size and were less expensive to maintain. Nonpropelled maintenance support barges had many attractive advantages in providing maintenance support for in-country craft and boats, such as:

1. The barges were available in WESTPAC assets and were placed into operation far earlier than comparable shore-based construction.

2. The barges could be tailored by in-country personnel to meet specific and changing maintenance needs.

3. They provided mobile flexibility and were moved by tugs to new locations as combat operations changed, providing an immediate support capability. The nonpropelled barge concept of maintenance support bases for Market Time, Game Warden, and the Riverine Forces was a major strength during the Vietnam conflict.

(5) In-Country Maintenance Performance

(a) The levels of maintenance for all in-country ships, craft, and boats for Market Time, Game Warden, riverine support, and the lighterage programs were identified in logistic planning which was integrated into facility planning. It was difficult and time consuming to arrange transportation to Subic Bay or Japan for depot repair; therefore, a combination of mobile afloat maintenance assets and shorebased facilities were established in the Corps Areas in consonance with the level of repairs to be done at each site. Major maintenance facilities at Da Nang, Cam Ranh Bay, An Thoi, Binh Thuy, Nha Be, Chu Lai, and Dong Tam had the capabilities of performing depot level overhauls on assigned PBR, PCF, WPB, and River Assault Craft. As an example, riverine patrol boat PBR-13 sustained 80 percent battle damage and was completely rebuilt in 3 months, including fabrication of a new fiberglass hull. Of particular importance were the Navy's afloat maintenance assets which ranged from repair ships to nonpropelled barges. Most of the afloat assets were modified and all were outfitted for their in-country support roles. Many of the barges came from reserve assets which were available at Subic Bay and Guam, emerging after modification with new missions and tasks and tailored to provide optimum support within the capability of the craft.

(b) Without exception, shorebased construction was not ready and the Navy's mobile assets were called upon to provide either interim or full support. Despite spartan maintenance facilities, the planning was well conceived and the in-country maintenance efforts were exceptional and provided flexibility to respond to new and different requirements. This was a major Navy strength identified to the Vietnam era which is attested by the high operational readiness index and craft availability shown in Figure 18. These statistics include combat craft and battle damage.[36]

e. Support of Ships in the Continental United States During the Vietnam Era

(1) U.S. Naval and Private Shipyards

(a) From their early beginnings, naval shipyards have been a part of the Navy Shore Establishment and have been providing a full range of material and technical support to men and ships afloat in order to meet the operational and strategic requirements imposed upon them. As of 1 January 1965 the Navy had eleven naval shipyards, six on the east coast, four on the west coast, and one in Hawaii. On 1 January 1965, the U.S. Naval Ship Repair Facility, San Diego, was closed, followed on 30 June 1966, in the midst of the buildup, by the closing of the New York Naval Shipyard. On the west coast, San Francisco Naval Shipyard and Mare Island Naval Shipyard were combined and identified as one shipyard, and subsequently separated again in FY 1970.

(b) During World War II, the maximum employment in the naval shipyard complex at any one time was 353,000 in July 1943. After World War II, naval shipyard employment trended downward to a level of about 68,000 in May 1950. During the Korean War, naval shipyard employment increased to about 140,000. At start of the Vietnam buildup the employment level was 85,000, which increased to 94,595 in September 1967.[37] The existence of new construction work in some naval shipyards during peacetime provided a means of maintaining skills and capabilities required for maintenance work during peak or emergency work periods.

(c) In 1964, the Chief of Naval Operations stated that the Naval shipyard industrial capabilities were a part of the strategic requirements of the Operating Forces.[38] The requirement for two shipyards on each coast with aircraft carrier repair capability ensured that these ships received organic support and protection against the nonavailability of capacity due to facility overload or a disaster. New York Naval Shipyard was engaged in this type of work until disestablished. The requirement for three shipyards on each Coast capable of overhauling nuclear submarines and of performing difficult electronics and missile system work was based on the volume of such work existing and forecast. However, all naval shipyards, with the addition of minor facilities and the development of certain personnel skills, could achieve an efficient complex electronics and missile system capability. The geographic location of naval shipyards in relation to fleet operating and training area, home ports, and nuclear propulsion plant and Polaris missile support responsibilities was a major factor in determining their capabilities.

(d) Some private shipyards had the capabilities needed to meet one or more of the strategic requirements. Newport News Shipbuilding and Drydock Company, for example, had the capabilities required to perform a nuclear propelled aircraft carrier overhaul. However, the large Newport News drydock, which was integral to this capability, was regularly used for new construction work and its availability for repair work could not be assured. Similarly, the Electric Boat Division of General Dynamics had the capability to overhaul nuclear submarines. In assignment of overhaul and repair work it was essential that only assured capabilities be given favorable consideration in meeting the strategic requirements for fleet readiness. This

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[36] Rear Admiral D. H. Jackson, USN, U.S. Pacific Fleet Maintenance Officer, Interview and Data from CINCPACFLT Operational Readiness Files for In-Country Combat Craft, 4 December 1969.

[37] Office of the Chief of Naval Operations, Memorandum, subject: Logistics Posture at Start of Vietnam Buildup, Maintenance Support, Ships, 29 June 1969; Naval Ships Systems Command Headquarters, Monthly Reports of Civilian Personnel Fiscal Year 1965-69.

[38] Office of the Chief of Naval Operations, Memorandum, subject: Logistics Posture at Start of Vietnam Buildup Maintenance Support, Ships, 29 June 1969.

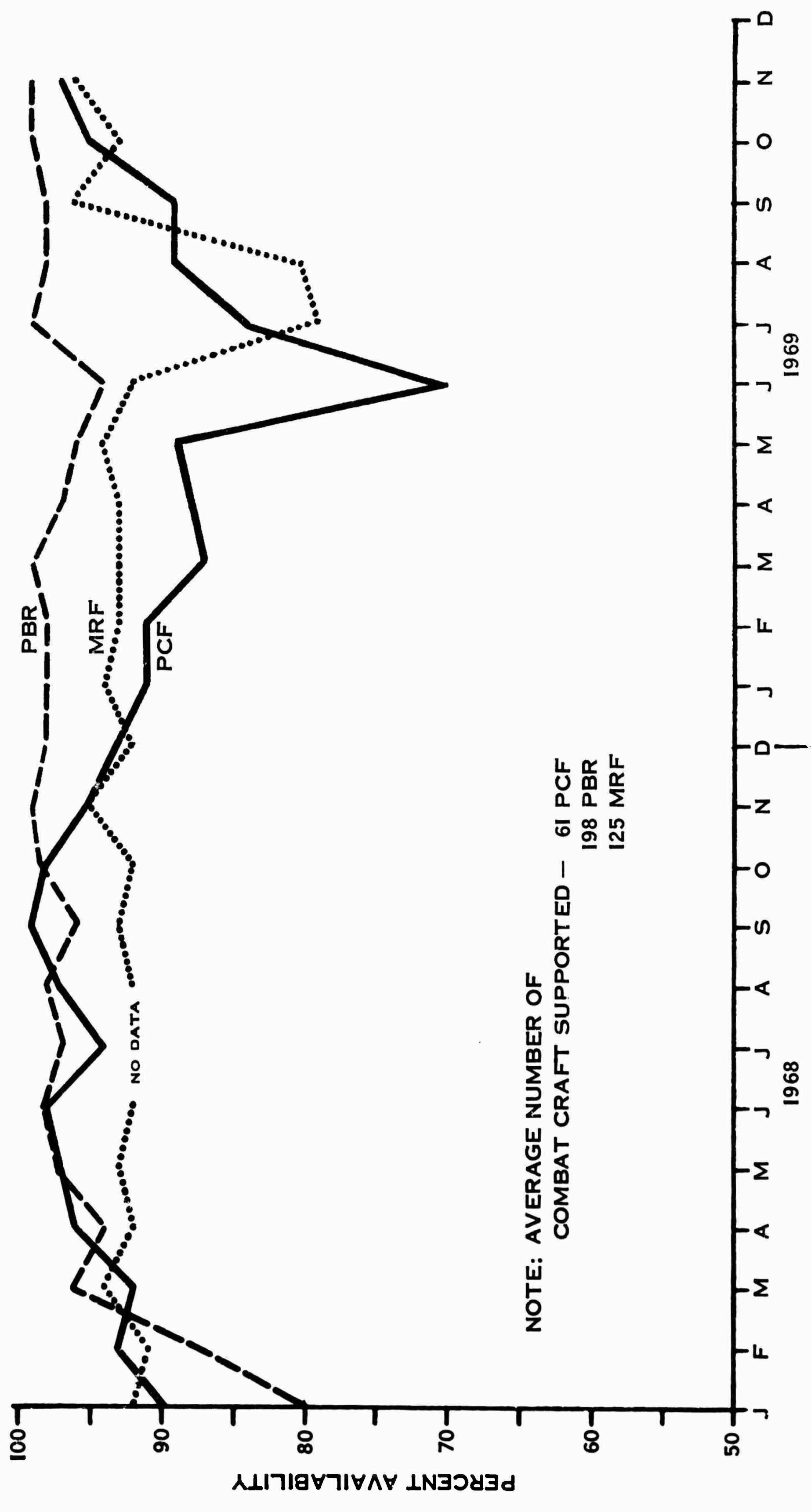

FIGURE 18. OPERATIONAL READINESS SUMMARY

responsibility was normally reserved for naval shipyards. However, for nuclear repair and overhaul work, it was necessary to depend on the nuclear shipbuilders because the naval shipyards had not acquired sufficient in-house capability.

(e) Overhauls accounted for approximately 80 percent of the shipyard workload. The remaining 20 percent was expended on restricted availabilities which, when possible, were scheduled in advance, such as for major ships returning after extended deployments. Table 22 provides data on naval shipyard productive capacities and utilization prior to and during the Vietnam era.

TABLE 22

NAVAL SHIPYARD PRODUCTIVE CAPACITIES AND UTILIZATION

			1 January 1965			During Vietnam Era			
Naval Shipyard	Personnel Employment Capacity (Thousands)		Personnel Employment	Utilization		Personnel Employment Peak		Utilization Peak	
	Max*	Opt**		Max (%)	Opt (%)	No.	Date	Max (%)	Opt (%)
Portsmouth	20.5	10.3	8,019	39	78	8,612	Aug 68	42	84
Boston	50.2	11.9	7,130	14	60	8,261	July 67	16	70
New York	69.1	15.1	9,935	14	66	(Disestablished 30 June 1966)			
Philadelphia	46.5	12.8	7,664	17	60	12,480	Nov 67	28	98
Norfolk	42.4	16.9	9,507	22	56	11,672	Oct 67	27	69
Charleston	26.0	8.3	5,685	22	68	8,398	Oct 67	33	100
Long Beach	16.0	8.4	5,306	33	63	8,519	Aug 67	53	101
San Francisco	17.2	11.8	6,337	37	54				
Mare Island	39.8	13.3	9,243	23	69	21,017	Dec 67		
Puget Sound	31.1	16.3	8,763	28	54	10,807	Aug 67	35	67
Pearl Harbor	24.9	6.1	4,706	19	77	6,203	Nov 67	25	102

*Maximum capacity represents the peak level during World War II.
**Optimum designates the most economical level of operation.

Source: Office of the Chief of Naval Operations, Memorandum, subject: Logistics Posture at Start of Vietnam Buildup, Maintenance Support, Ships, 29 June 1969; Naval Ships Systems Command Headquarters, Monthly Reports of Civilian Personnel Fiscal Year 1965-69.

(f) Throughout the Vietnam conflict ship maintenance requirements continued to expand but there was no concomitant increase in major west coast shipyard repair facilities. Rising costs for material and labor and heavy workloads in key shipyard repair shops affected naval and private shipyards. Emergency repairs of combatants, such as those required by USS ORISKANY (CVA 43) after a disastrous fire, resulted in delays of other ships in overhaul and undergoing conversion. Despite efforts to remain within ship repair cost estimates, with industrial assistance only for essential work items beyond the capability or capacity of forces afloat, ship repair costs escalated. In the San Francisco area, for example, the cost per estimated man-day increased 116 percent between FYs 64 and 67, as shown in Figure 19.[39] In the Long Beach area the bid prices submitted by private ship repair activities consistently exceeded the Supervisor of Shipbuilding estimates by 25 percent or more. These high costs were due primarily to the high workloads in commercial facilities, the high tempo of operations, and the electricians strike in the 12th and 13th Naval Districts.

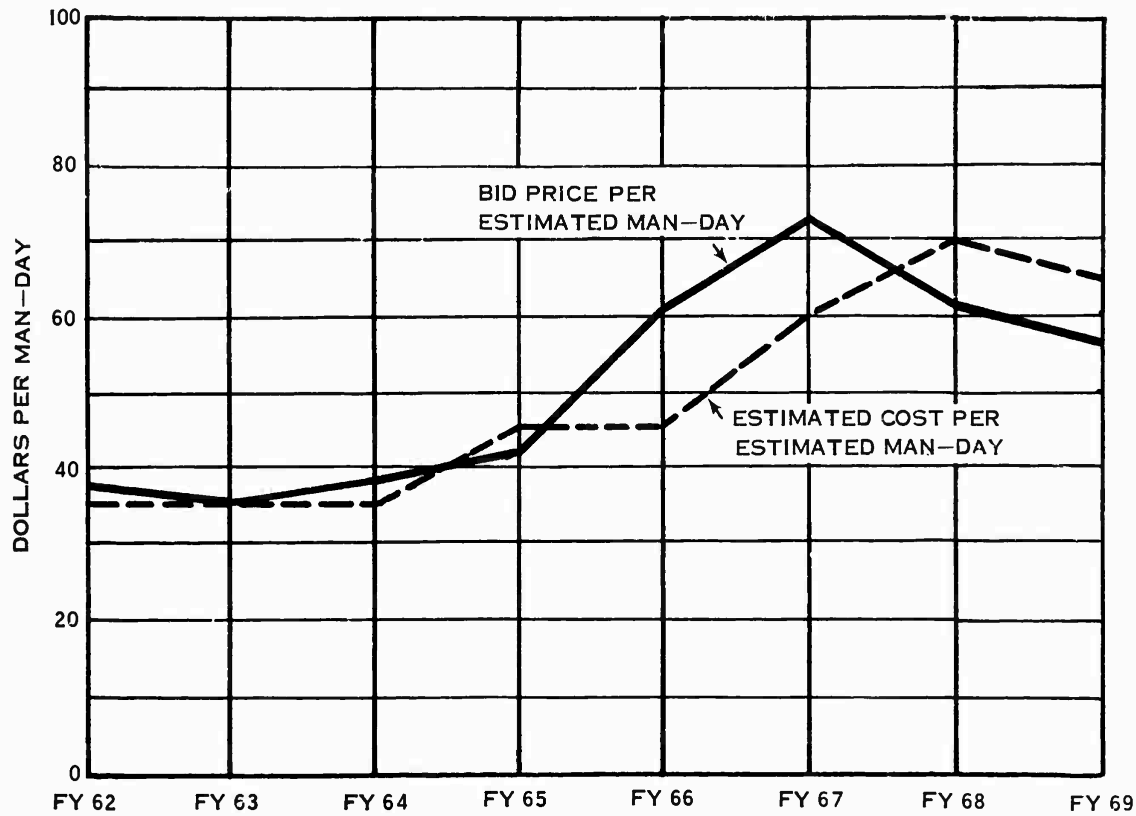

FIGURE 19. COST OF SHIP REPAIR IN PRIVATE SHIPYARDS IN THE SAN FRANCISCO AREA

(g) A major weakness of the naval shipyards was obsolescent and inadequate facilities. The shipyards were using World War I facilities, and World War II machinery to repair ships in 1965. The yards facilities were built and configured to handle the problems of past wars. Since World War II the size and complexity of ships had increased to where new destroyers were the size of World War II light cruisers. The SQS-23 and SQS-26 sonars have added considerable depth below the keel of ships; therefore drydocks built for previous destroyers did not fit new ships. Originally, shipyard strength was in steam propulsion plant repairs and steel fabrication, but this had changed to the requirement to service the precision equipment contained in combatant warfare systems and nuclear propulsion plants. Additionally, the shipyards had inadequate position welding equipment, weight and materials handling equipment, numerically controlled machine tools and precision electronics and weapons repair and calibration facilities.

(h) The problem of naval shipyard obsolescence has been recognized and thoroughly examined. A long-range program has been initiated to replace older equipment with

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[39] U.S. Navy, Operations of the Service Force, U.S. Pacific Fleet, Fiscal Year 1967, 11 July 1967, pp. 20-25; Mr. William B. Morris, Acting Planning Officer, Office of Supervisor of Shipbuilding Conversion and Repair, 12th Naval District, telephone interview, 12 February 1970.

equipment that is faster and more efficient, modernize many facilities and provide new repair capabilities. At the time of writing, the estimated cost of the modernization program exceeds one billion dollars extended over a 10-year period. Obsolescence in naval shipyards contributed to increased time to perform certain types of work and overall higher repair and overhaul costs during the Vietnam era. Similar problems existed in the private commercial shipyards.

(2) West Coast Labor Strikes

(a) In June 1966, the Secretary of Defense directed that the percentage of overtime for the FY 67 budget was to be approximately the same as that actually experienced in FY 64 and FY 65.[40] Five months later the International Brotherhood of Electrical Workers struck all west coast commercial shipyards north of Monterey, California. The strike caught many fleet units in private shipyards. On 10 December 1966, the Secretary of the Navy reported to the Secretary of Defense that "the continual heavy workload in our Naval Material Command, particularly in our shipyards, aircraft rework facilities, and in munitions movement and production, has prevented us from staying within our revised overtime plan for the first six months of FY 1967. To carry on our planned programs, and to meet the increased workload caused by several recent emergencies and the labor strikes at private shipyards on the West Coast, an additional authorization of $14.1 million in overtime work was needed for the month of December 1966. It was estimated that between 80 and 85 percent of our total increased overtime requirements of $51.1 million above our initial overtime plan for the first months of FY 67 are related to Southeast Asia efforts."[41]

(b) By January 1967, the crippling effect of the electrical workers' strike began to interfere with the fleet's operations in SE Asia. On 9 January 1967, Commander, Service Force, U.S. Pacific Fleet, recommended the seeking of Presidential action. On 10 March 1967, an 80-day injunction under the Taft-Hartley Act was obtained. At the end of the injunction period the electrical workers voluntarily continued working during union-management negotiations. Although naval shipyards were not directly involved in the strike, they were compelled to absorb much of the urgent repair work not capable of being completed by other activities. The net result of the numerous associated problems regarding ship repair was that a total of 1,209 ship operating days were lost due to extension of overhauls during FY 67, the equivalent loss of three ships.[42]

(c) In FY 68, a 4-month labor strike at two San Diego private shipyards again had an adverse impact on all west coast shipyard repair workloads. Although the naval shipyards were again not directly involved in the strike, they were required to absorb much of the more urgent repairs that could not be completed by the commercial yards being struck. Consequently, a total of 21 regular overhauls and restricted availabilities to Pacific Fleet ships, home ported at San Diego, where the ship's personnel families were located, had to be reassigned outside the San Diego area.[43] The reduced industrial capacity at San Diego and the resulting overload experienced in other areas, particularly Long Beach, resulted in significant delays in both starts and completions of assigned availabilities.

(d) The full impact of the closing of the U.S. Naval Ship Repair Facility, San Diego, was felt in terms of higher repair costs and a decrease in ship's personnel morale because of ship maintenance reassignments outside the San Diego area. The closing of the New York Naval Shipyard had the noticeable effect of redistributing the workload to other shipyards without any significant total east coast employment reductions during the Vietnam era. For example, Philadelphia Naval Shipyard employment increased approximately 60 percent after New York was closed.

[40] Secretary of Defense, Letter, subject: Control Over DOD Overtime Costs, 20 June 1966.
[41] U.S. Navy, Secretary of the Navy, Memorandum, subject: Control of Overtime Costs, 10 December 1966.
[42] Naval Ship System Command Management Office, Western Pacific Area, Letter, subject: Pacific Fleet Overhaul Extensions Fiscal Years 1967-69, 12 December 1969.
[43] U.S. Navy, Operations of the Service Force, U.S. Pacific Fleet, Fiscal Year 1968, 1 September 1968, p. 3-3.

(e) During the height of the Vietnam buildup the workload in both Government and private shipyards on the Pacific Coast was extremely heavy. For example, the workload grew in Long Beach Naval Shipyard from 63 percent of optimum utilization of facilities on 1 January 1965 to 101 percent in October 1967. Similar high workload increases occurred at the two Government shipyards in the San Francisco Bay area and at Pearl Harbor. Although the exact percentage of ship repair and overhaul work on contract to private shipyards on the west coast was not available, the overall Navy percentage varied from 25.6 percent in FY 65 to 40.6 percent in FY 66, followed by a reduction to 26.2 percent in FY 69.[44] With both overtime and manpower rigidly controlled, the U.S. naval shipyard reaction capability to unscheduled and unpredicted workload surges was insufficiently flexible, often resulting in late ship completions and creations of backlogs of essential work, including new construction.

(f) When the private shipyards were struck there existed some doubt that the available west coast shipyard capacity, both Government and private, would be sufficient to meet SE Asia requirements. The absence of air attacks and submarine warfare against ships in SE Asia resulted in a minimal amount of direct Seventh Fleet battle damage. Major concern existed that the available Pacific and west coast repair capacity, already heavily taxed without battle damage, would not have been sufficient to meet Pacific Fleet maintenance requirements had battle damage been a factor.

(3) Naval Shipyard Personnel Ceiling and Overtime Restrictions

(a) Naval shipyards are subject to Government civilian personnel ceiling controls and formal numerical restrictive controls on overtime which constrain effective workload management. Naval shipyards are Navy Industrial Fund activities and all work performed for the fleet was done on a reimbursable basis. The imposition of ceiling and overtime limitations was often inconsistent with the corrective maintenance workload which the shipyard was funded to perform. A substantial surge capacity was available through the use of overtime. Restrictive controls on overtime had been used intermittently. They were in effect in FY 65, removed in FY 66, reinstated in FY 67, and again removed in FY 69 and FY 70. In practice, the control of ceilings and of overtime tended to work at cross-purposes and did not promote timely and economical program management. In a naval shipyard endeavoring to perform authorized corrective maintenance by a required delivery date and within approved funds, a shortage of overtime authority resulted in a demand for increased manpower ceilings. Conversely, a lack of adequate manpower ceilings required the necessary labor hours to be performed by overtime. As an example, three attack aircraft carriers were under concurrent overhaul in two east coast naval shipyards. One carrier had returned from Vietnam and one would deploy soon after the overhaul. Each shipyard was compelled to reduce the scope of the overhaul work because of insufficient manpower and overtime restrictions. In a period of escalating workload, Governmental ceiling reductions had been directed and were being implemented. Consequently the onboard civilian personnel count was decreasing in the face of a rising funded workload.

(b) The constraints placed on naval shipyards and aircraft rework facilities reduced the ability of the Navy to respond to its mission-essential requirements during the Vietnam era. The Secretary of the Navy twice requested that DOD remove numerical controls on ceilings and overtime for Navy industrial funded activities.[45] In the latter part of FY 69 and for FY 70, overtime fund limitations were removed. No assurance exists that this constraint would not be reimposed in the future. At the time of writing, DOD had not responded to the Navy's request for removal of personnel ceiling controls.

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[44] U.S. Navy, Navy Ships Systems Command Headquarters, Point Paper, Allocation of Ship Work Between Naval and Private Shipyards, 1953-1970, 15 May 1969.

[45] Secretary of the Navy, Memorandum, subject: Improvements in Management Control Techniques, 5 May 1967; Assistant Secretary of the Navy (Comptroller), Memorandum, subject: Civilian Employment Limitations, 19 February 1969.

3. NAVAL AND MARINE CORPS AVIATION

a. General

(1) The greatest strength of naval aviation maintenance support in January, 1965 was the aircraft carrier and the high degree of mobile organizational and intermediate maintenance self-sufficiency it ensured for the embarked air wing and squadrons. Personnel, materiel, and facility resources were already available, organized, and supporting air operations in these mobile bases. Extensive repair capabilities and moderate repair capacities existed in each carrier and at each supporting shore station. Capabilities and capacities have been further developed during the SE Asia operation. Particularly significant was the formation of a new department in the carriers, the Aircraft Intermediate Maintenance Department (AIMD), which has improved intermediate maintenance support of embarked squadrons. Personnel, materiel, and facility resources were available in 1965 to rapidly extend operations and increase their tempo in response to SE Asia demands. However, reduction in readiness had to be accepted elsewhere.[46]

(2) The Department of Defense's three levels of maintenance—organizational, intermediate, and depot—are used by Naval aviation and, together with Maintenance Engineering Instructions, form the basis for the Naval Aircraft Maintenance Program and its logistic support. However, significant variations exist within the Navy and Marine Corps as to which detailed functions are performed at which level. The Navy initially developed six levels of maintenance to meet its needs: two within each one of the three DOD levels. Although this might have standardized most of the variations involved, it was found too difficult to define the difference between two levels within each of the DOD intermediate and depot levels. Any valid approach had to recognize the needs of the organizations involved and the missions, tasks, and equipments to be assigned. Flexibility and responsiveness to operational requirements were major considerations, particularly those imposed by rapid deployments to areas requiring sustained high tempo operations. Differences were usually related to the degree of self-sufficiency required by the organizations involved. The most visible differences occur at the intermediate maintenance level; usually in the degree of repair to be performed in a forward area. The present Naval Aircraft Maintenance Program policy is repair at the lowest level that is practical and economical.[47]

(3) The Naval Aircraft Maintenance Program delineates command relationships, classifies maintenance functions to DOD maintenance levels, and assigns maintenance responsibilities to all maintenance activities.[48] The effectiveness of maintenance and materiel support provided to naval aviation during the Vietnam era is presented in Figures 20, 21, and 22, which compare the total number of flight hours for each model aircraft and the Not Operational Rates for Supply (NORS) and Maintenance (NORM).[49]

(4) Figure 20 compares two well established models, the A-4 and F-4 aircraft, which performed the majority of Navy flights. The A-4 had a low value of NORS and NORM, with a slightly increasing trend as the flight hours increased that may be attributed to the age of the aircraft (10 years). The F-4 shows a downward trend for maintenance effort but higher values than for the A-4 due to the greater complexity. NORM decreased as experience was gained in weapons system maintenance.

(5) Figure 21 compares the A-6 aircraft and the H-46 helicopter. These were newer aircraft and had similar numbers of flight hours, although the A-6 had more weapons systems. Both aircraft experienced a reduction of NORM and NORS as maintenance experience was gained and supply support improved.

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[46] Joint Logistics Review Board, Briefing by the Chief of Naval Operations Staff, subject: The Naval Aircraft Maintenance Program, 18 July 1969.
[47] Chief of Naval Operations Instruction 5400.5c, Naval Aircraft Maintenance Program, 24 February 1964.
[48] Chief of Naval Operations Manual Naval Aircraft Maintenance Program, 15 November 1964.
[49] Naval Air Systems Command, Data gathered by the Aviation Maintenance Data Collection System.

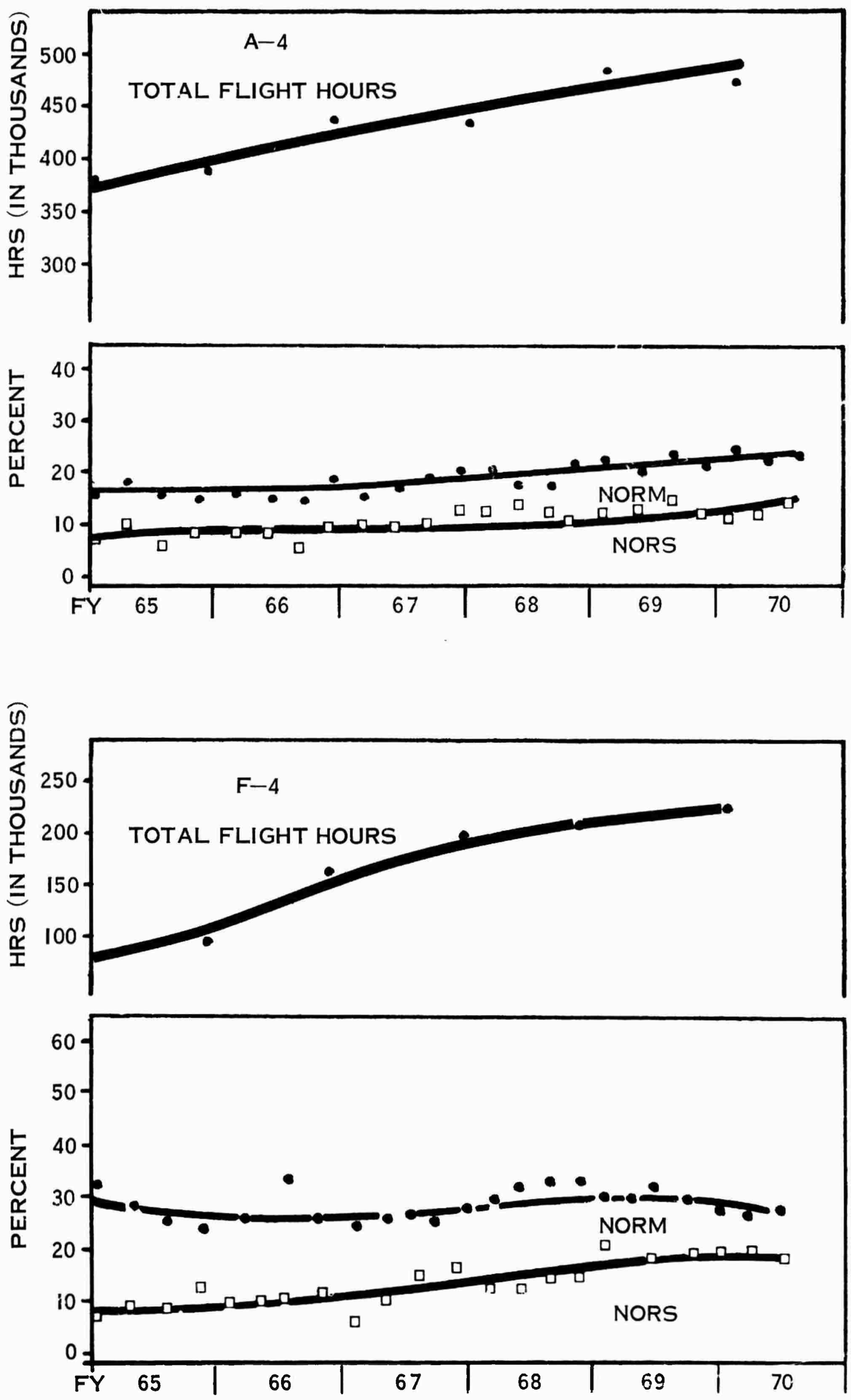
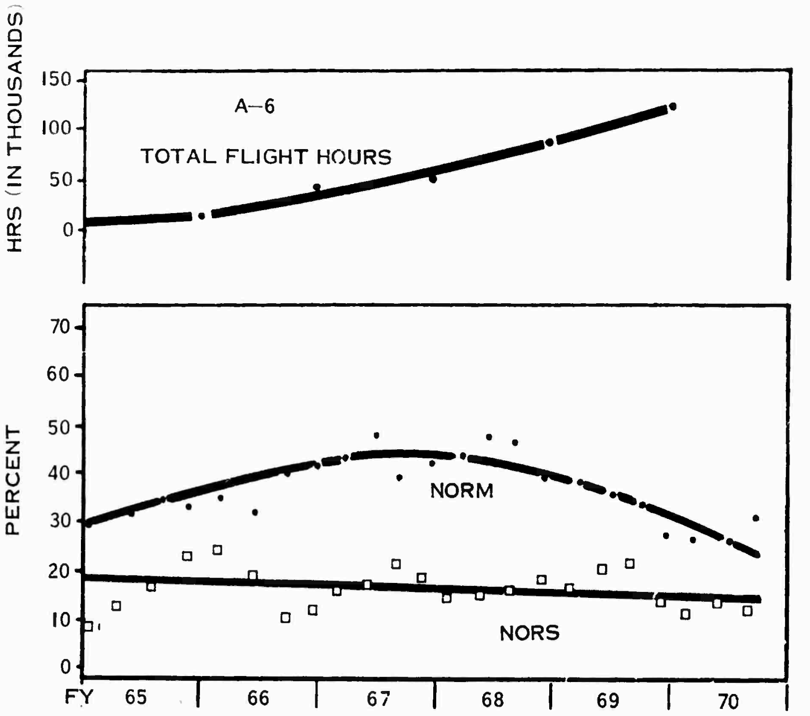


FIGURE 20. A-4 AND F-4 AIRCRAFT SUPPORT

Source: Naval Air Systems Command Monthly Aviation Maintenance Data Reports.



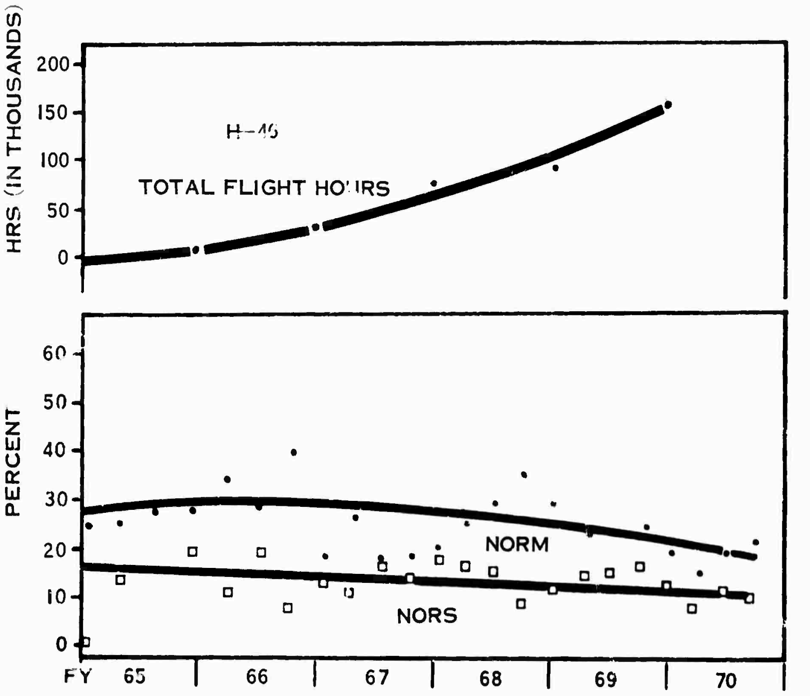


FIGURE 21. A-6 AND H-46 AIRCRAFT SUPPORT

Source: Naval Air Systems Command Monthly Aviation Maintenance Data Reports.

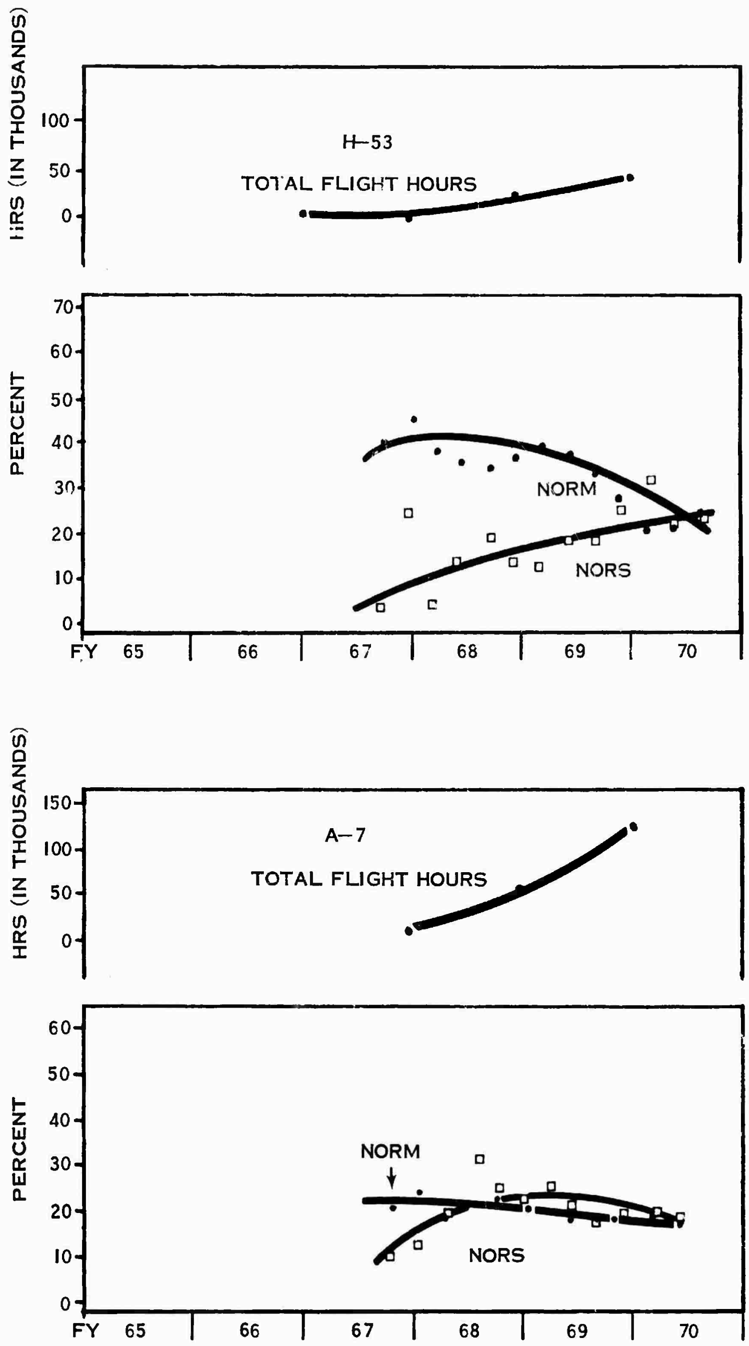


FIGURE 22. H-53 AND A-7 AIRCRAFT SUPPORT

Source: Naval Air Systems Command Monthly Aviation Maintenance Data Reports.

(6) Figure 22 shows the effect of introducing new aircraft models during the Vietnam era. The A-7 and H-53 were introduced in 1967 with a sharp increase in NORS due to the delay of usage data to pre-position repair parts. The NORM decreases steadily as experience is gained and fewer modifications are introduced in each aircraft.

(7) Maintenance support during the Vietnam era was responsive in meeting the requirements of operational commanders but not without problems. The introduction of several new weapons systems posed problems that had to be solved concurrently:[50]

(a) Supporting systems and equipments were almost as complex as the aircraft themselves.

(b) The lack of depot maintenance capability in or near the combat area and/or the lack of equipment pipeline inventories precluded proper equipment support.

(c) The shortage of spare parts made controlled cannibalization a way of life.

(d) Reliability and maintainability deficiencies required major contractor personnel assistance.

(e) Modifications resulting from these deficiencies and operational experience imposed unplanned workloads that required contractor modification teams in the forward area.

(f) Combat damage required replacement aircraft that were not available and resulted in deploying naval air rework facility teams to the forward area.

(8) The buildup of activity and the accelerated usage of spares and repair parts caused the number of high priority supply requisitions to reach unprecedented proportions. Naval aviation units were provided a status reporting system designated as NORS AIR which reported by the most rapid means possible to the Aviation Supply Office those requisitions and parts needed to prevent a specific tail number aircraft from being grounded. The system was inaugurated in March of 1966 and provided the intensive management action necessary to move those high priority requisitions associated with grounding of an aircraft. The movement of defective reparables had already been identified as a problem area by the Fleet Logistics Supply Improvement Program of 1964, which instituted the Critical Aviation Material Expediting List (CAMEL) program. This procedure has been in effect all during the Vietnam era and causes aviation reparables to be moved on a priority basis, back to the designated overhaul point or naval aircraft rework facility.

(9) The Naval Aviation Maintenance and Material Management (3M) system for aviation was introduced in 1963 and implemented in 1965. The 3M system provided new techniques, procedures and equipment for improved management at the organizational and intermediate levels. Various improvements were designed to integrate the efforts of both maintenance and supply in meeting the increased utilization of equipment with no increase in manpower or spares. As a management tool, the computerized 3M system enabled aviation commanders at all levels to monitor and more effectively control their aircraft maintenance efforts.[51]

(10) The DOD policy to defer procurement of aviation advanced attrition and pipeline inventories prior to the Vietnam era resulted in a shortage of spares and repair parts after the Vietnam buildup commenced. The 3M system included production control procedures and provided repair cycle information that permitted local managers to reduce the average repair cycle at the intermediate level to about 3 days, which reduced the requirement for spare components.[52]

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[50] Joint Logistics Review Board, Briefing by Chief of Naval Operations Staff, subject: The Naval Aircraft Maintenance Program, 18 July 1969.

[51] Joint Logistics Review Board, Briefing by the Naval Material Command, subject: Navy 3M System for Ships and Aircraft, 20 August 1969.

[52] U.S. Navy, Data from Maintenance Support Office, Monthly Intermediate Maintenance Activity Reports.

(11) An important change was made in the intermediate maintenance organization on board attack and antisubmarine warfare aircraft carriers in 1966. Prior to that time, the intermediate maintenance department for aviation was not a part of the aircraft carrier organization until the air wing arrived on board, which made aircraft support slow to develop for each deployment. A permanent intermediate maintenance organization provided personnel to maintain and modify test equipment, maintain the integrity of shops, and to establish the 3M maintenance control and management system needed for the effective support of the air wing.

(12) Aviation ground support equipment (GSE) was in a poor state of readiness at the beginning of 1965 with little attention being given to the development of improved equipment as jet aircraft entered the fleet. Ground support and test equipment had increased in complexity and had become an important part of modern weapons systems. The need for a planned maintenance program was clearly indicated. The Naval Air Systems Command recognized the importance of aviation ground support equipment by forming a division with that title within the organization responsible for development and procurement of new aircraft and weapons systems. Also, a program was initiated for the formation of an enlisted rate, an aviation ground support technician to be trained in the maintenance and repair of this equipment.[53]

(13) The loss of naval aircraft due to combat without the procurement of replacements had a twofold detrimental effect upon maintenance. Aircraft that had been previously retired from the Active Fleet became replacements that required modification for combat service in Vietnam, and these older aircraft required more maintenance support to attain the same level of readiness.

(14) The painted surfaces of aircraft were well protected and trouble-free until a scratch or small opening allowed salt water to reach the aluminum surface. Intergranular corrosion and stress corrosion developed at a rapid rate. Once detected, the corroded area required additional maintenance to remove the oxidized metal without further damage; a treatment to arrest the corrosion; and the application of a well bonded covering.

(15) Logistics strengths and weaknesses related to these and other problems were revealed as a result of SE Asia operations.

b. Offshore Support

(1) The greatest weakness of naval aviation maintenance support in January 1965 was the lack of aircraft, personnel, materiel, facilities, and pipeline resources to sustain SE Asia operations without major aircraft, engine, and armament equipment repair and modification capability in the area of operations. In response to this situation, the Naval Air Station (NAS), Cubi Point, Philippine Islands, was augmented with Naval Air Rework Facility (NARF) aircraft and engine repair teams, contractor aircraft and electronic countermeasures modification teams, and Naval Air Engineering Service Unit (NAESU) calibration teams. Major spare parts, support equipment, and facility investments were also provided. NARF repair teams were later placed in-country to support Marine Corps air operations. This pipeline/repair deficiency would again be a major weakness in a future conflict unless the necessary pipeline resources or forward area shorebased or mobile repair capability were available. Continuing efforts are being made to determine the optimum balance between pipeline investments and forward area repair capabilities.[54]

(2) Intermediate level shorebased support was provided by the Naval Support Unit at Iwakuni, the Naval Air Facility at Naha, the Naval Air Station at Agana, and the Naval Station at Sangley Point; all with Aircraft Maintenance Departments providing support primarily for patrol and special mission squadrons. Sangley Point also provided direct selected item support to the Naval Air Facility at Cam Ranh Bay for in-country patrol and special mission squadrons and units.

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[53] U.S. Navy, OPNAV Instruction 35500.26B, Aviation Support Equipment (ASE), Operator/Organizational Maintenance Training Program: Establishment of, 30 January 1969.

[54] Joint Logistics Review Board, Briefing by Chief of Naval Operations Staff, subject: The Naval Aircraft Maintenance Program, 18 July 1969.

(3) Naval Air Station, Atsugi, and Naval Air Station, Cubi Point, Aircraft Maintenance Departments provided support for locally based Helicopter Utility and Rescue, Electronic Reconnaissance, Utility, and Transport squadrons and detachments. More significantly, they provided direct selected item support for the following aviation activities:

(a) Attack, antisubmarine, and amphibious assault carriers, underway replenishment, and air-sea rescue ships of the Seventh Fleet.

(b) Marine Air Groups assigned to the First Marine Air Wing.

(c) Electronic Reconnaissance, Transport, and Photographic Reconnaissance detachments operating in-country.[55]

(4) A majority of the damage sustained by naval aircraft during the Vietnam era required that the aircraft be transported to CONUS naval aircraft rework facilities (NARFs) for repair. The Navy instituted a "pipeline" study in 1965 to recommend methods of reducing the time aircraft were out of service during depot level maintenance.[56] It was found that some of the aircraft damage requiring depot level repair was not very extensive and could have been repaired with relatively few man-hours of effort in SE Asia by specialized personnel. As a result, the Naval Air Systems Command established the Special Techniques for Repair and Analysis of Aircraft Damage (STRAAD) unit at the Naval Air Station, Cubi Point, to effect depot level repairs with personnel from the several NAEFs. Within 12 hours of notification that an aircraft had been damaged in Vietnam or on board an aircraft carrier, a team was evaluating the damage. Repairs could often be made on-site, using the men of the organizational unit under the supervision of the depot repair technicians. The Naval Air Station at Cubi Point was selected because:

(a) No depot maintenance capability existed in the SE Asia area. The nearest was Japanese contract maintenance.

(b) Cubi Point had the best facilities available in the area.

(c) Carriers periodically returned to Cubi Point for other purposes and off-loaded damaged aircraft.

Over 2,100 aircraft were repaired at Cubi Point or for Marine Corps units and aboard aircraft carriers during the 3-year period from 1966 to 1969. An average of 175 man-hours was expended in the repair of each aircraft. Without these repairs, over 5,000 aircraft months would have been lost during transportation to and from the continental United States.[57]

(5) Depot level maintenance was performed on Navy support aircraft and Marine Corps aircraft that remained in the Pacific area under contract to Japanese industry. Seven contractors in Japan and one Taiwan contractor were provided Government-furnished equipment and parts to perform depot maintenance under the direction of the Fleet Air Western Pacific Repair Activity (FAWPRA). Contract maintenance provided a cost avoidance because 15 percent fewer logistics and support aircraft were provided to WESTPAC activities due to the shorter transportation time to Japan. Marine Corps aircraft required a total of nine days transportation to the continental United States.[58]

c. In-Country Support

(1) Additional strength was provided by Marine Air Groups, with organizational maintenance performed in each tactical squadron, and intermediate maintenance performed in

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[55] Ibid.
[56] U.S. Navy, Center for Naval Analysis, Study Number 18, subject: Naval Aircraft Pipeline Study, 8 May 1968.
[57] Joint Logistics Review Board, Briefing by Naval Air Systems Command, subject: Naval Aviation Depot Level Maintenance Program, 29 April 1969.
[58] Ibid.

each tactical squadron and by the Headquarters and Maintenance squadrons in each group. This group/squadron organizational team again emphasized mobility, self-sufficiency, and readiness. Airliftable mobile maintenance facilities (vans) were under development in 1965, and extensive avionics facilities were available. This development continues with increasing mobile organizational and intermediate maintenance capability and capacity in each group. When deployed in-country SE Asia, these groups were able to support their own operations at squadron and group level.[59]

(2) Navy construction battalions (Sea Bees) were responsible for the construction of a major portion of the naval aviation maintenance facilities in Vietnam. They completed the 8,000 foot runway at Chu Lai in 23 days and later the additional maintenance and operations facilities at Da Nang, Chu Lai, and the Air Defense Base on Monkey Mountain. The Short Airfield for Tactical Support (SATS) system was added at Chu Lai by June 1965. SATS was well suited for use in Vietnam where jet-capable airfields were limited.

(3) Within the SATS concept was the necessity to provide a means to maintain increasingly complex aircraft and support equipment in a state of readiness. The Marine Air Groups were organized to perform organizational and intermediate maintenance as far forward as possible and also remain mobile. In an effort to achieve these objectives, the Marine Corps developed various airliftable mobile maintenance vans to provide an operational capability immediately upon arrival at a SATS site. The concept was tested in SE Asia and the vans provided the required maintenance support for Marine Corps objectives.

(4) Continued refinements in the SATS concept emphasizes an optimum van complex design with standard unit dimensions. This effort will provide the facility requirements for the planned functional workload responsibilities assigned to each maintenance level. Further, materiel support requirements were structured to the maintenance level responsibility. This function is presently undergoing a change from a manual to a mechanized method of operations, thereby increasing support responsiveness. Units in SE Asia effected this change in the expeditionary environment. In short, all efforts are directed toward a responsive and mobile maintenance program.

(5) The van concept was introduced early in Vietnam by outfitting existing service trailers with test equipment at the Naval Aircraft Rework Facility (NARF), San Diego, California. Commercially procured equipment could not meet the time or cost limitations, but the NARF diverted manpower from aircraft modification and repair programs to meet this in-country requirement.

(6) Structural deficiencies and the lack of forward area maintenance facilities and pipeline aircraft caused the entire fleet of Marine Corps CH-46 helicopters to be shipped to the Marine Corps Air Facility at Futema, Okinawa, for extensive depot level repairs. The necessity for promptly correcting the aircraft's structural deficiencies was underscored by the fact that the 105 Marine CH-46's in the Western Pacific represented 48 percent of the helicopter cargo lift and 47 percent of the personnel lift capability of the III Marine Amphibious Force.

(7) Aircraft in Vietnam encountered an unexpected increase in damage to the T-58 jet engine due to abrasive sand and dust. The damaged engines would normally have been returned to a depot facility in the continental United States for repair except pipeline engines were not available. It was found that the compressor section did not require special tools and was within the capability of intermediate activities to remove and replace damaged or eroded compressor blades. Marine Corps and Navy intermediate activities effected the repair and thereby met operational requirements with the limited assets that were available. This was a part of the Complete Engine Repair (CER) program also in effect at the naval aircraft rework facilities.

(8) The deployment of complex avionics equipment to areas remote to established calibration laboratories created a serious maintenance problem in Vietnam. Therefore, a

[59] Joint Logistics Review Board, Briefing by Chief of Naval Operations Staff, subject: The Naval Aircraft Maintenance Program, 18 July 1969.

calibration complex (ICE CUBE) was established at Chu Lai, in April 1967, to provide support for most weapon systems and the calibration of avionics test equipment. ICE CUBE provided a timely response for a major portion of the requirements that would have been evacuated to laboratories in Japan or the Philippines for calibration. The complex was initially manned by Marine and civilian technicians; however, Marines replaced the civilians by 1 January 1968. The spectometric oil analysis program (SOAP) was added in January 1969 to provide analysis of engine oil and helicopter transmission oil samples to assist in forecasting aircraft engine and power train failures.[60]

(9) The SPARROW III (AIM-7D/E) missile became a maintenance problem in 1965 resulting from high usage for combat air patrol missions. The number of rejected missiles requiring depot repair in CONUS increased. The long pipeline soon depleted the SPARROW III inventory aboard aircraft carriers. The Navy launched a major study[61] which reported that a high percentage of the SPARROW III missiles that were returned to the depot did not require repair. An intermediate level test facility was established at the Naval Air Station, Cubi Point, and all SPARROW III missile rejections from Marine Corps air wings and aircraft carriers were validated. About 30 percent of the missiles that would have been shipped to depot repair were returned to service by the intermediate maintenance activity at Cubi Point and defective missiles were closely monitored to reduce the pipeline time back to the depot. The added maintenance effort permitted operation within the limited inventory of SPARROW III missiles without additional procurements.

d. Continental United States Support

(1) The seven CONUS naval aircraft rework facilities provided the necessary rapid depot maintenance response to support SE Asia Naval and Marine Corps air operations. Their flexibility in response to ever-changing combat requirements was invaluable. Their capability and capacity continues to improve.[62]

(2) The in-house capability of the naval aviation depot repair facilities were severely taxed by the rapid buildup in SE Asia, the increased tempo of operations, the combat damage that greatly increased the workload content for a given aircraft, and the requirement to modify aircraft for service in SE Asia. Also contributing to an unbalanced workload was the introduction of the A-6 all-weather attack aircraft in several versions, a new version of the F-4 with a more complex fire control system, and the new A-7 attack aircraft. These programs tended to increase the number of man-hours required for a given progressive aircraft rework over that of the previous, less complex aircraft.

(3) During the period from 1965 through 1969, the naval aircraft rework facilities experienced a 50 percent increase in workload with only a small change in personnel assigned as follows:[63]

1965 – 28,337	1968 – 36,211
1966 – 30,350	1969 – 37,709
1967 – 35,415	1970 – 31,537

The estimated investment cost of facilities and equipment for the NARFs is shown in Table 23 with the annual operating budget expended by each of the facilities.

[60] Naval Air Systems Command Instruction 4730.8, Aeronautical Oil Analysis Program, 5 June 1963.
[61] Naval Air Systems Command, Letter, Serial 0491, subject: Air-to-Air Missile Systems Capability Review, 24 June 1969.
[62] Joint Logistics Review Board, Briefing by Chief of Naval Operations Staff, subject: Naval Aircraft Maintenance Program, 18 July 1969.
[63] Joint Logistics Review Board, Briefing, Naval Air Systems Command, subject: Naval Aviation Depot Level Maintenance Program, 29 April 1969.

TABLE 23

NAVAL AIRCRAFT REWORK FACILITIES
INVESTMENT AND FUNDING
(Costs in Millions of Dollars)

Rework Activity	Land Acres	Land Cost	Buildings No.	Buildings Cost	Class 3 & 4 Equip. Cost	FY 69 Oper. Budget	Civ. Pers.
Alameda	162	0.66	67	20.21	34.03	138.24	7,652
Cherry Point	91	1.34	12	16.42	19.77	50.49	2,795
Jacksonville	105	0.53	38	14.85	20.42	66.97	3,577
Norfolk	92	0.06	77	22.28	29.06	109.76	6,014
North Island	298	0.17	71	13.20	37.34	144.44	7,645
Pensacola	322	5.24	83	16.86	21.48	82.37	4,802
Quonset Point	62	0.09	35	16.02	18.71	48.83	3,327
Total	1,132	8.09	383	119.84	180.81	641.10	35,812

Total Cost of Land	8.09
Total Cost of Buildings	119.84
Total Cost of Equipments	180.81
Total Investment	308.74

Source: Joint Logistics Review Board, Briefing by Naval Air Systems Command, subject: Naval Aviation Depot Level Maintenance Program, 29 April 1969.

(4) The Naval Air Systems Command had developed an automated long-range workload planning system which included the shop capacity, floor space, personnel, funding, aircraft force structure, and utilization rates necessary to predict the capability of the NARFs to meet the maintenance requirements of the fleet. The system indicated a lack of depot capacity which resulted in the shifting of repair for some aircraft to different NARFs and other aircraft to be placed under contract with industry for the progressive aircraft rework. The system proved invaluable in allocating limited resources to the most urgent needs and also validated the shortage of facilities needed to meet future requirements. A 5-year modernization program has been authorized which is estimated to save $424.39 million in military construction and $112.47 million operating and maintenance funds over a 5-year period due to the possible savings in manhours.[64]

(5) The loss of Navy and Marine Corps aircraft without the procurement of replacements forced the Navy to retain aircraft that would normally be removed from combat service or required that the configuration of other aircraft be changed to operate successfully in the SE Asia environment. Installation of these changes represented increased costs, but the Office of the Secretary of Defense (OSD) was unable to recognize them during budget approval procedures. Therefore, since FY 68 the depot maintenance program has been seriously underfunded. In the years prior to FY 67, the Navy normally carried about 350 aircraft in a deferred depot level maintenance status, or aircraft operating beyond the time when they should have been inducted

[64]U.S. Navy Operations, Point Paper OP515, Naval Aircraft Rework Facility Modernization and Expansion Program, 18 July 1969.

for rework. As a result of the underfunding in FY 68, the number of aircraft deferred reached 898.

(6) Two major events occurred during FYs 68 and 69 which affected the depot maintenance program. Beginning in FY 69 under the Resources Management System, Operations and Maintenance, Navy (O&MN), began to pay for large amounts of materiel which were formerly received at no cost from the procurement accounts. This resulted in a change of cognizance over this materiel from the procurement accounts to the Navy Stock Fund, and decreased the funds available. Also during FY 68 the Navy, through engineering analyses, maximized the number of months an aircraft could operate between the Progressive Aircraft Rework (PAR) or rework cycle time. Had this not been done, the number of aircraft on deferred maintenance at the end of FY 69 would have exceeded 1,100.[65]

(7) Naval and Marine Corps aircraft are inspected and reworked on a calendar basis in lieu of an hourly inspection which was a Royal Navy concept. The calendar inspection method was selected after reviewing all aircraft inspection systems in use—military, business, and commercial. The calendar system has been beneficial to the Navy because of reduced scheduling effort at the squadron level, compatibility with carrier deployments, and ease of depot rework scheduling. Aircraft must be inspected whether they are flown or not, which also encourages the flying of each aircraft more equitably. The maximum flying hours which are expected to occur within a particular calendar interval are carefully considered prior to setting an interval and continuously monitored thereafter.

(8) The average man-hours expended on each aircraft during rework increased considerably due to increased complexity, modifications and utilization as shown in Figure 23. However, the personnel required for the workload compared with the number of employees authorized is shown in Figure 24. The difference between the two curves represents the work that could have been accomplished within existing Navy depot facilities but had to be placed under contract to civilian industry due to lack of personnel or overtime authorization. The effect of Civil Service ceiling controls and the limitations placed on the expenditure of overtime funds on industrially funded activities is discussed in Chapter IX and in the Financial Management monograph, Chapter VII.

(9) In regard to comparisons between rework in Navy organic capacity and work performed by contract or interservice:

> "Quality: equally good from all sources
> Responsiveness: vast difference. Organic facilities were completely responsive. Interservice capacity is satisfactory as long as the schedules established in the interservice agreements are held to. All three services experience difficulty in rapidly responding to increases in these schedules since such changes invariably would result in failure to perform certain work for the operating forces of the performing service. Responsiveness of contractors to change schedules or work specifications rapidly was totally unacceptable because of contract renegotiation procedures."[66]

(10) In order to gain increased productivity with the same work force, overtime was necessary. Industrial funds were available for the required work, but the Secretary of Defense limitation on overtime expenditures caused other elements of the Navy to be denied overtime funds (see Chapter IX, Depot Maintenance). The use of increased overtime revealed a cost avoidance because of the relationship between indirect and direct labor costs when operating at 10 percent overtime. Direct labor personnel could work effectively without additional supervisory, quality assurance and administrative personnel and without the additional fringe benefits paid if additional personnel were placed on the payroll.[67]

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[65] Joint Logistics Review Board, Briefing by Naval Air Systems Command, subject: Naval Aviation Depot Level Maintenance Program, 29 April 1969.

[66] Ibid.

[67] Ibid.

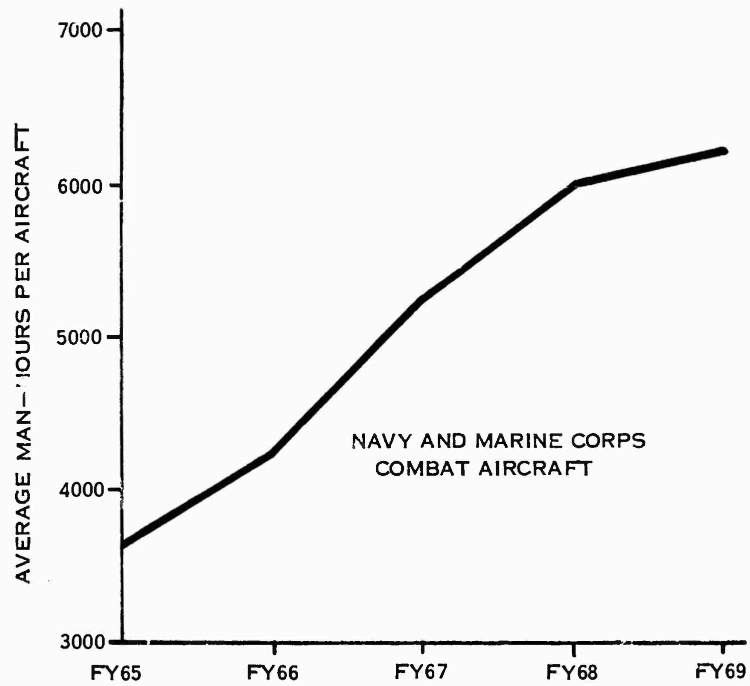

FIGURE 23. MAN-HOURS REQUIRED FOR AIRCRAFT REWORK

Source: Naval Air Systems Command, Briefing to the Joint Logistics Review Board, subject: The Naval Depot Level Maintenance Program, 29 April 1969.

(11) The component repair program at the naval aircraft rework facilities was also the source of increased workloads to be accomplished with limited funds and manpower. The Naval Integrated Component Repair Scheduling Program (NICRSP) had been in effect since 1964 to provide a weekly production schedule comparing supply system requirements for reparables with the available funds and manpower at the seven rework facilities. The NICRSP system clearly identified the required cost of repairing defective materials either by NARFs or by contract to industry. However, known requirements fell short of required fundings, as shown in Table 24. Deficit funding for reparables decreased the stock levels throughout the Navy. In turn, the NICRSP scheduling technique programmed the repair of components with either a back order or zero balance at a higher workload priority.

(12) The combination of increased management attention at the intermediate maintenance level coupled with the NICRSP scheduling technique at the naval aircraft rework facilities provided the systems needed to meet the requirements of the fleet with limited assets yet stay within the constraints imposed by higher headquarters. The Aviation Maintenance Data Collection System could provide the NICRSP program with additional information concerning reparables, as discussed in Chapter XII, Reparables Processing.

(13) The Complete Engine Repair (CER) program originally developed for the intermediate repair level was also introduced at the depot level. Each aircraft engine that had not reached the maximum time interval was more carefully disassembled to determine if only a small amount of depot repair was necessary to return the engine to service. Considerable savings have been realized from this program, since about 15 percent of the engines returned for depot repair can be repaired as necessary and complete the remaining operating hours before the engines require a complete overhaul.

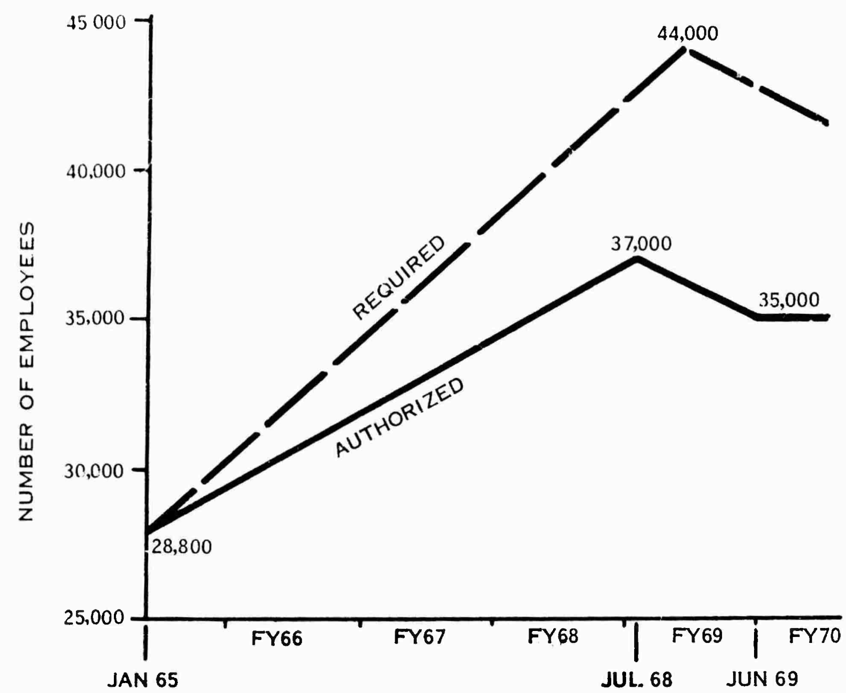

FIGURE 24. NAVAL AIRCRAFT REWORK FACILITIES MANPOWER

Source: Naval Air Systems Command, Briefing to the Joint Logistics Review Board, subject: The Naval Depot Level Maintenance Program, 29 April 1969.

TABLE 24

STATUS OF FUNDS FOR REPARABLES
(Millions of Dollars)

Fiscal Year	Navy Request	Congress Approval	Deficit
1967	998.7	776.0	-187.8
1968	855.4	579.6	-249.2
1969	548.2	373.6	-260.6

Source: SECNAV Management Information Center Briefing, 24 October 1969.

4. STRENGTHS, WEAKNESSES, AND LESSONS LEARNED

a. Strengths

(1) The Navy's maintenance concept, requiring trained forces in-being which operate both in peacetime and in war, enabled an immediate responsive buildup of naval forces in SE Asia. The greatest strength of Navy maintenance during the Vietnam era was that the organization of each afloat and shore command included an organic maintenance capability with the ability to meet changing and unforeseen requirements.

(2) Naval aircraft carriers provided a high degree of mobile organizational and intermediate maintenance self-sufficiency necessary to sustain operations of embarked air wings and squadrons during the Vietnam conflict.

(3) The Marine Aircraft Group had an in-being organization which provided responsive mobile and self-sufficient maintenance support of deployed Marine aircraft during the Vietnam era.

(4) The Short Airfield for Tactical Support system permitted Marine Corps Aviation to provide tactical air support that was not otherwise available in Vietnam. Airliftable mobile maintenance vans included in the system enabled the establishment of a prompt organizational and intermediate level maintenance capability in each Air Group.

(5) The training of officer, enlisted, and civilian maintenance personnel within the Navy placed emphasis on the use of initiative and solving the problem at the lowest levels with the tools and facilities available. The ability of afloat and ashore repair activities to support a wide variety of equipment was possible only through the responsiveness of flexibility of maintenance personnel in applying their training skills to the new requirements.

(6) The placing of all WESTPAC ship repair facilities, supply depots, and other support activities under the same fleet command as the mobile support forces provided effective maintenance support to the operating forces through integrated workload coordination of afloat and ashore resources by:

(a) Sharper focus on fleet needs.

(b) Closer coupling of the WESTPAC ship repair facilities with the supply depots, enhancing their maintenance responsiveness through tailored programs designed to identify repair parts requirements and to position materiel where it was needed.

(c) Providing mobile maintenance support in-country and offshore in WESTPAC areas having no repair facilities, or to augment existing shorebased industrial facilities to meet maintenance requirements. Use of repair ships permitted establishment of mobile in-country maintenance bases in areas where construction of shorebased facilities was not feasible.

(7) Throughout the Vietnam era, organic depot level ships maintenance capability permitted rapid response to emergencies and unscheduled repair work concurrently with orderly growth to meet expanding requirements. Major workloads, such as the Military Assistance Program ship overhauls, were effectively shifted to other repair activities (which permitted continuation of this important program) while concurrently releasing important maintenance resources for the Seventh Fleet and in-country demands. Contract maintenance of depot level repair work in WESTPAC was utilized only to accommodate the less urgent workloads. This was an economical and effective method of meeting heavy unscheduled workload demands which permitted WESTPAC Navy maintenance facilities to concentrate on the most urgent work.

(8) The Navy's Vietnam Market Time, Game Warden and Riverine Force maintenance support was well planned and effectively met the unanticipated in-country maintenance support. The flexibility and mobility of these craft, augmented with equipment from the Advanced Base Facility Component System, made them major maintenance resources. This also emphasized the advantage of retaining selective assets left over from prior wars.

(9) The depot maintenance capability of naval aviation in the forward area was expanded by increasing contract maintenance performed in Japan and by augmenting existing naval air stations with both organic and contract maintenance teams to meet the emergency and unscheduled repair requirements of Vietnam.

(10) Throughout the Vietnam era, the Navy's Maintenance and Material Management (3M) system improved shipboard and aircraft maintenance management at the organizational and intermediate levels. The 3M system for aviation integrated the logistics management of supply

and maintenance at the ship and station level. This improved control of aviation reparables components resulted in fewer components in the repair cycle.

(11) The Vietnam era proved the value of the Navy Integrated Component Repair Scheduling Program which was started in 1964 at naval aircraft rework facilities. The weekly production schedule provided a comparison of reparable component requirements and available depot funds and manpower which effectively ensured management visibility of critical pipeline reparable requirements needed to support SE Asia.

b. Weaknesses

(1) The advanced age of a majority of Navy ships and aircraft during the Vietnam era escalated the maintenance workload and costs to keep them operational. Older ships and aircraft lacked margin for growth to permit installation of new equipment to meet changing threats; many ships lacked adequate habitability for operations in the climate of SE Asia.

(2) The Navy experienced difficulty in maintaining old and obsolescent equipment that either had been retained in the active inventory or reactivated as a direct result of the Vietnam conflict. Time consuming and expensive repair or manufacture was often necessary as a substitute for purchase of items which were no longer in production.

(3) The fragmented shipbuilding construction programs after World War II encouraged participation of many different contractors and small business equipment suppliers. The variety of makes and models of equipment installed in ships and craft caused maintenance support problems, particularly to deployed forces.

(4) In the absence of a Reserve callup, the Navy was forced to draw down experienced maintenance personnel from the fleet to support in-country billet requirements. This had two important consequences:

(a) The quality and quantity of shipboard maintenance was lowered, resulting in a greater demand for higher cost work to be done by shorebased facilities both in the Western Pacific and in the United States.

(b) Shipboard maintenance became largely a matter of corrective, vice preventive, maintenance by overworked ship's maintenance personnel. This had the adverse effect of reducing the personnel retention rates in the shipboard maintenance areas which required the most attention, such as boilers and machinery.

(5) Certain inequitable United States Civil Service employment regulations and procedures discouraged acceptance of employment at expanding overseas bases directly supporting military operations in Vietnam. There was little incentive for high quality United States civilian employees to accept overseas employment for professional growth.

(6) Without exception, the in-country Market Time and Game Warden bases did not complete on schedule because of construction delays. This necessitated use of the bases before they were ready.

(7) The application of peacetime military construction submission, review, and approval procedures for activities in direct support of combat forces in SE Asia contributed to delays in facility expansion at the U.S. Naval Ship Repair Facility, Subic Bay.

(8) There existed a lack of drydock capacity under United States control for large ships in SE Asia.

(9) Marginal maintenance funding of the Navy's floating drydocks in the years prior to the Vietnam buildup had reduced their capability for self-sufficient operation when the buildup commenced.

(10) In the years prior to 1965, austere funding had generated unsatisfied depot level maintenance requirements for ships and aircraft. With the Vietnam buildup, the combined effect of deferred maintenance backlog, aging equipment, and the heavy tempo of operations caused increasing materiel casualty and failure rates which generated large corrective maintenance costs that required supplemental funding.

(11) The depot maintenance programs for ship alterations and aircraft modifications were underfunded prior to and throughout the Vietnam era.

(12) The DOD policy to defer procurement of aviation advanced attrition and pipeline inventories prior to the Vietnam era resulted in the lack of replacement aircraft and a shortage of spares and repair parts early in the buildup.

(13) Requirements generated by changing SE Asia operations usually preceded, by long time frames, the funding, establishment of new personnel ceilings, and construction of facilities in support of the requirements at naval industrial activities.

(14) Control of civilian personnel ceilings and overtime placed on continental United States naval shipyards and aircraft rework facilities reduced the ability of the Navy to respond to its mission essential requirements during the Vietnam era. Unscheduled priority repairs caused previously scheduled work to be deferred or placed under contract to private industry at additional cost. (See also Chapter IX, Depot Maintenance, and the Financial Management monograph, Chapter IX.)

(15) United States naval shipyards, private shipyards, and naval aircraft rework facilities lacked modernization, which contributed to increased time to perform certain types of work and overall higher repair and overhaul costs during the Vietnam era.

(16) Marginal maintenance funding and lack of maintenance management prior to the Vietnam buildup resulted in reduced numbers and a shortage of aviation ground support equipment for aircraft carrier deployments.

c. Lessons Learned

(1) The Navy's maintenance concepts and policies proved reliable and required no significant changes for the Vietnam conflict.

(2) The Vietnam conflict emphasized the importance of the organic maintenance capability in responding to urgent unanticipated and unprogrammed maintenance requirements. The need for organic capability was demonstrated by the responsiveness of Pacific Fleet support, and with the rapidity with which in-country maintenance support was established. Preservation of this capability within the Navy is essential to meet future contingencies effectively.

(3) The expansion and establishment of advanced bases and in-country maintenance bases to support SE Asia requirements was necessary for efficient support of a military operation of such long duration. The Navy would normally remain independent of shorebased installations through the use of mobile maintenance equipment and the movement of unserviceable equipment to continental United States depots. However, the operational demand for serviceable equipment over such an extended period of time made it expedient to expand depot level repair facilities in SE Asia.

(4) The absence of air and submarine war against ships in SE Asia resulted in a minimal amount of direct Seventh Fleet battle damage. Because direct battle damage did not tax the Navy's industrial facilities during the Vietnam conflict, the amount of WESTPAC repair capability expansion that was developed would not have been as great, or necessary at all, except for the age and materiel condition of the fleet. Aging Navy ships and craft required more maintenance attention and more maintenance funding to remain combat capable. The ship repair workload in SE Asia will continue in proportion to age of ships deployed and the tempo of operations.

(5) The Navy lacked sufficient maintenance support ships and craft in the active fleet to meet SE Asia requirements when the buildup began. Assets were reactivated from the Reserve Fleet at many locations, and outfitted with equipment and repair personnel for their in-country mission. The preservation of these maintenance assets in both the Active and Reserve Fleets requires emphasis after Vietnam, with sufficient priority to survive in future austere funding environments.

(6) When the Vietnam buildup commenced, the Navy had no small combat craft in its inventory to satisfy in-country Market Time and Game Warden requirements. Because of the urgent need, commercial boat designs were purchased, adapted to Vietnam requirements, and mass-produced. With few exceptions, the boats proved successful. Use of commercial boats and equipment necessitated greater repair part support initially and throughout the life cycle because items were not intended for military use and the operating environment was more severe than anticipated.

(7) The Advanced Base Facility Component System proved to be an extremely useful maintenance asset for establishment of maintenance capabilities afloat and ashore and contributed to early capabilities for repair of in-country combat boats. Marginal funding in the years prior to the Vietnam buildup had not permitted replacement of obsolete equipment nor procurement of all necessary materials in support of the concept.

(8) The Vietnam conflict stressed the importance of a mobile organic drydocking capability. Of significance was the lack of drydocking capacity in SE Asia large enough to accommodate an attack aircraft carrier and other large ships. Fortunately, the drydocks in Japan were available for nonnuclear ships; however, this situation may not always exist. The Navy does not have a mobile, organic, self-sufficient drydocking capability for its largest ships equipped for use in advanced base anchorages.

(9) The extension of depot repair capability through the repair team concept effectively kept WESTPAC Navy ships and aircraft operational which otherwise would have required return to shorebased depot facilities in the Western Pacific or in the United States.

(10) Strikes in the West Coast private shipyards which resulted in substantial cost increases and delayed ships that were in the yards emphasized the following:

(a) The importance and reliability of Navy shipyard capabilities, which were called upon to complete the ships taken out of the strikebound yards.

(b) The importance of establishing sufficient Government controls which would ensure continuity of work on ships involved in direct support of combat operations in time of a full or limited national emergency.

(c) The uncertainty of completion of combat essential work in private shipyards during periods of heavy repair workloads and tight fleet operating schedules.

(11) The loss of Navy and Marine Corps aircraft in combat without compensatory procurement made it necessary to:

(a) Reactivate older aircraft which required extensive modifications in the continental United States to make them combat capable and required more maintenance support in the fleet to sustain the same level of readiness as newer aircraft.

(b) Deploy naval aircraft rework facility teams to Naval Air Station, Cubi Point, Philippines, and later in-country.

(12) The requirement for depot level repairs of crash and battle-damaged Navy and Marine Corps aircraft necessitated the expansion of repair capability at the Naval Air Station, Cubi Point, Philippine Islands. In 1966 the air station was augmented with organic depot repair teams and contract modification teams which enabled the Navy to reduce the number of aircraft and equipment in the pipeline inventory.

(13) Special Techniques for Repair and Analysis of Aircraft Damage (STRAAD) teams positioned at Cubi Point, Philippine Islands, in 1966 provided organic depot maintenance support to Naval and Marine Corps combat units in the forward area. Organic depot level repairs made on board aircraft carriers and in-country reduced the number of aircraft out of commission which otherwise would have required transportation to continental United States depots.

(14) Continental United States private industry was not responsive in meeting changes in schedules or in work specifications for contract aircraft depot level maintenance during the Vietnam era.

(15) By using overtime at an optimum economic level, naval aircraft rework facilities realized a cost avoidance through reduction of indirect expense as a proportion of total expense.

(16) The Navy and Marine Corps inspection of aircraft on a calendar basis, started in 1961, provided efficient maintenance scheduling, improved utilization of manpower, and better compatibility with the deployment schedules of aircraft carriers and Marine air wings.

(17) The automated long-range workload planning system, starting in 1968 at the naval aircraft rework facilities, identified the depot modernization requirements needed to meet increasing projected workloads. Modern facilities and equipment in aviation depots reduced maintenance costs.

(18) Improvements in maintenance were made through integrated maintenance and material programs. The application of a standard Maintenance and Material Management system provided maintenance programs, management techniques, and control of assets or resources through an information system at the lowest organizational level.

(19) The application of integrated logistics support concepts and programs in new and existing Navy equipment programs promises to make a substantial improvement in the maintenance and operation of Navy equipment.

5. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) The Navy's maintenance concept, requiring trained forces in-being which operate both in peacetime and in war, enabled an immediate responsive buildup of naval forces in SE Asia (paragraphs 1a, 1b (1)-(4), 3a, 3c, and 3d).

(2) When the Vietnam buildup began, the existence of WESTPAC afloat and ashore organic aviation and shipyard depot level maintenance capability permitted rapid response to emergencies and unscheduled repair work. The expansion of existing offshore bases and the establishment and development of in-country maintenance bases proved to be essential for efficient support of a military operation of long duration (paragraphs 2c (5)-(7), 3a, 3b, and 3d).

(3) The extension of depot repair capability through repair team concepts effectively kept WESTPAC Navy ships and aircraft operational which otherwise would have been required to return to shorebased depot facilities in the Western Pacific or in the United States (paragraphs 2c (10), 3a, 3b, and 3d).

(4) The combined effect of deferred maintenance backlog, aging equipment, and the heavy tempo of operations caused increasing materiel casualty rates which generated large corrective maintenance costs. Difficulty was experienced in maintaining old and obsolescent equipment that had been either retained in the active inventory or reactivated as a direct result of the Vietnam conflict. The variety of makes and models of equipment installed in ships and craft caused supply support and training problems, particularly for deployed forces (paragraphs 2a (1)-(4), 2b (1)-(3), 3a, 3d, and Volume I).

(5) Throughout the Vietnam era, the Navy's Maintenance and Material Management System improved shipboard and aircraft maintenance management at the organizational and intermediate levels. The Aviation Maintenance and Material Management system integrated the logistics management of supply and maintenance at the ship and station level. This improved control of aviation reparable components resulted in fewer components in the repair cycle (paragraphs 1d (1)-(5) and 3a).

(6) There was little incentive for high quality United States civilian employees to accept overseas employment. Certain civil service regulations affected wage rates and promulgation of wage increases which discouraged qualified wage board personnel from accepting employment at expanding overseas bases directly supporting military operations in Vietnam. Long lead times often resulted when recruiting to fill overseas job vacancies with competent United States civilian employees (paragraph 2c (5) (f)).

(7) Control of civilian personnel ceilings and overtime placed on continental United States naval shipyards and aircraft rework facilities reduced the ability of the Navy to respond to requirements during the Vietnam era. Unscheduled priority repairs caused previously scheduled work to be deferred or placed under contract to private industry at additional cost (paragraphs 2e (3)). (See also Chapter IX, Depot Maintenance, and the Financial Management monograph, Chapter IX.)

(8) Naval aircraft carriers provided a high degree of mobile organizational and intermediate maintenance self-sufficiency necessary to sustain operations of embarked air wings and squadrons during the Vietnam conflict (paragraph 3a).

(9) The Marine Air Group had an in-being organization and provided responsive mobile and self-sufficient support of deployed Marine aircraft during the Vietnam era. The airliftable mobile maintenance vans included in the Short Airfield for Tactical Support system enabled the establishment of a prompt maintenance capability in-country (paragraph 3c).

(10) The requirement for depot level repairs of crash and battle-damaged Navy and Marine Corps aircraft necessitated the expansion of repair capability at the Naval Air Station, Cubi Point, Philippine Islands. In 1966 the air station was augmented with organic depot repair teams and contract modification teams. Of particular importance was the Special Techniques for Repair and Analysis of Aircraft Damage (STRAAD) team which, starting in January 1966, provided depot maintenance support in the Philippines and in-country, thereby reducing the number of aircraft and equipment in the pipeline inventory (paragraphs 3a, 3b, and 3d).

(11) The Vietnam era proved the value of the Navy Integrated Component Repair Scheduling Program (NICRSP) which was started in 1964. The weekly production schedule since 1965 provided a comparison of reparable component requirements and available depot funds and manpower which effectively ensured management visibility of critical pipeline requirements needed to support SE Asia (paragraph 3d).

(12) The Navy and Marine Corps inspection of aircraft on a calendar basis was stated in 1961 and provided efficient maintenance scheduling, improved utilization of manpower, and better compatibility with the deployment schedules of aircraft carriers and Marine air wings (paragraph 3d).

(13) The deferral of procurement for aviation advanced attrition and pipeline inventories prior to the Vietnam era resulted in a shortage of spares and repair parts after the Vietnam buildup began (paragraph 3a).

(14) The automated long-range workload planning system, starting in 1968 at the naval aircraft rework facilities, identified the depot modernization requirements needed to meet increasing projected workloads. Modern facilities and equipment in aviation depots reduced maintenance costs. By using overtime at an optimum economic level, a cost saving was realized by reduction of indirect expense as a proportion of total expense (paragraph 3d).

(15) Organic depot maintenance activities were highly responsive to urgent requirements. In the case of contracts to industry, changes in schedules or work specifications to meet urgent requirements could not always be renegotiated in suitable time frames. The effect of manpower constraints caused an increase in the quantity of maintenance placed on contract (paragraph 3d). (See also Chapter IX, Depot Maintenance, and the Financial Management monograph, Chapter VII.)

(16) The Navy's concept of ship self-sufficiency established the basis for ship maintenance, which is distinguished by difference in capability rather than by the type of maintenance performed. Ship maintenance of necessity overlaps the restrictive three divisions of maintenance—organizational, intermediate, and depot level—established by the Office of the Secretary of Defense. As a consequence, OSD maintenance policy guidance based on the premise of three distinct divisions of maintenance is not always strictly applicable to naval ship maintenance (paragraphs 1b (1)-(4)).

(17) In the absence of a Reserve callup, the Navy was forced to draw down experienced maintenance personnel from the fleet to support in-country billet requirements. This had two important consequences:

(a) The quality and quantity of ship maintenance was lowered, resulting in a greater demand for higher cost work by shorebased facilities both in the Western Pacific and in the United States.

(b) Ship maintenance became largely a matter of corrective, vice preventive, maintenance by overworked ship maintenance personnel (paragraph 2b (3)(a)5).

(18) Optimum workload coordination and improved maintenance support to the Operating Forces was achieved by placing all Western Pacific ship repair facilities, supply depots, and other support activities under the same command as the mobile support units (paragraph 2b (3)(a)5).

(19) The specialized expertise of the Navy's mobile technical units reduced shipboard electronic and ordnance equipment downtime through on-the-job training, combined with ship's force repair of equipment failures.

(20) The Navy's Western Pacific ship repair facilities provided essential depot level maintenance support for the fleet, accomplished activations and conversions of ships and craft for service in Vietnam, and provided direct in-country maintenance support. The growth of the Navy ship repair facilities in the Western Pacific was necessary because of the age, material condition, and the tempo operations of the fleet (paragraphs 2c(5)-(9) and 2c(11)).

(21) Shifting the bulk of the Western Pacific Military Assistance Program ship overhaul to Guam permitted continuation of this important program while concurrently releasing important resources in the Philippines and Japan for the Seventh Fleet and in-country maintenance demands (paragraphs 2c(5)-(7) and 2c(9)).

(22) Despite some disadvantages, a reasonable workload should be continued at the U.S. Naval Ship Repair Facility, Guam, since it is the only such facility located on United States Territory in the Western Pacific (paragraph 2c(6)).

(23) Depot level maintenance contracting of repair work in WESTPAC was used to accommodate the less urgent workloads. This was an economical and effective means of meeting heavy unscheduled workload demands which permitted WESTPAC Navy maintenance facilities to concentrate on the most urgent work (paragraphs 2c(5)-(8)).

(24) The concept of the credit system for Military Assistance Program ship maintenance in foreign shipyards provides a means of improving the United States balance of payments (paragraph 2c(9)).

(25) The Vietnam conflict stressed the importance of a mobile organic drydocking capacity. The only drydocks for the Navy's largest ships in the Western Pacific were in a foreign country (paragraph 2c(3)).

(26) The Navy's changing and unforeseen Vietnam Market Time, Game Warden, and Riverine Force maintenance requirements were effectively met through expansion of in-being organic capacity. The use of ships and craft from the Active and Inactive Fleet enabled early establishment of mobile in-country maintenance bases, provided maintenance support where no repair facilities existed, and augmented existing shorebased industrial facilities. The conversion of Inactive Reserve nonpropelled barges to mobile afloat barges made them major maintenance resources (paragraphs 2d(1)-(5)).

(27) The Advanced Base Facility Component System proved to be an extremely useful maintenance asset for establishment of maintenance capabilities afloat and ashore and contributed to early capabilities for repair of in-country craft and boats (paragraphs 2d(3)).

(28) Strikes in west coast private shipyards during the height of the Vietnam buildup reduced the entire west coast depot level ship maintenance capacity to a marginal level. The strikes resulted in substantial cost increases and delayed the completion of ships. United States naval shipyards were called upon to complete many ships taken out of the strikebound yards, which emphasized the importance and reliability of an organic shipyard capability (paragraph 2e(2)).

b. Recommendations. The Board recommends that:

(MT-5) The Department of the Navy sponsor a study applicable to all Services of its overseas Civil Service programs and propose appropriate action to the Office of the Secretary of Defense that would provide incentives to attract the required number of highly qualified Wage Board and Graded Classification Act personnel necessary to supervise and train indigenous workers at overseas facilities (conclusion (6)).

(MT-6) The Office of the Secretary of Defense coordinate with the Treasury Department to obtain approval to establish a formal program implementing a credit system, allowing U.S.-manufactured products to be used for payment of services rendered by a foreign shipyard or contractor for United States ship repair work (conclusion (24)).

Note: Recommendations concerning the control of overtime, Civil Service ceilings, and the development of a reasonably stable posture for depot maintenance activities are contained in Chapter IX, Depot Maintenance, and the Financial Management Monograph, Chapter IX .

CHAPTER V
MARINE CORPS MAINTENANCE

1. GENERAL

a. Concept

(1) The Marine Corps concept of logistic support is to provide a system specifically designed for the support of amphibious or land operations in concert with the Navy, utilizing the basic Marine air-ground team principle of exploiting, under a single tactical command, the capabilities for amphibious landings, helicopterborne mobility, and the immediate control of organic attack aircraft and artillery. The logistic system is executed by means of tailored task organizations to conform to the size and makeup of the tactical units, supported initially by prepositioned stocks and automatic resupply.

(2) The Marine Corps maintenance concept is to keep combat serviceable equipment in Fleet Marine Force units to maintain a force-in-readiness posture by repairing equipment at the lowest echelon possible which will not detract from combat mobility, accomplishing repairs as quickly and economically as possible, and disposing of uneconomically reparable items when in the best interest of the Government.

(a) Maintenance Flow. The flow of maintenance for Marine Corps ground equipment is shown in Figure 25.

(b) Value. The value of the equipment in use by the Marine Corps as of 30 June 1969 was $1,259 million. Of that total, $1,126 million was in the organic units of the Fleet Marine Forces, a $247 million increase over FY 68. The inventory within the Marine Corps Stores System as of 30 June 1969 was $1,887,000.[1]

(c) Maintenance Personnel. The personnel required for the maintenance function within the Marine Corps is depicted in Tables 25, 26, and 27.

(3) Task organization of the tactical units proved to be a significant factor for Marine Corps forces in Vietnam by providing a flexible means to meet deployments. Due to the combat situation which developed, the logistic support units were also task organized to support each combat base. This logistic structure has persisted throughout the Vietnam conflict.[2]

(4) Maintenance elements of combat service support units were organizationally structured to provide the necessary flexibility to accommodate the maintenance requirements of a variety of task organizations. Elements of division, wing, and force combat service support units were assigned to the tactical units to provide the maintenance capability dictated by the tactical situation.

(5) The Marine Corps participates in other service equipment development programs. A significant range of end items and systems is obtained from other military services, primarily the Army. In these instances the Marine Corps supports and participates in the development and maintenance engineering activity conducted by the Army to ensure that logistic support considerations will be compatible for the Fleet Marine Force application. The same is true for the Navy in the case of the family of amphibian tractors. Where a project manager or system program office has been established that affects the Marine Corps, full participation is

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[1] Department of Defense, Real and Personal Property of the Department of Defense as of 30 June 1969, 1969.
[2] U.S. Marine Corps, Briefing, subject: Marine Corps Maintenance Management System, 7 May 1969.

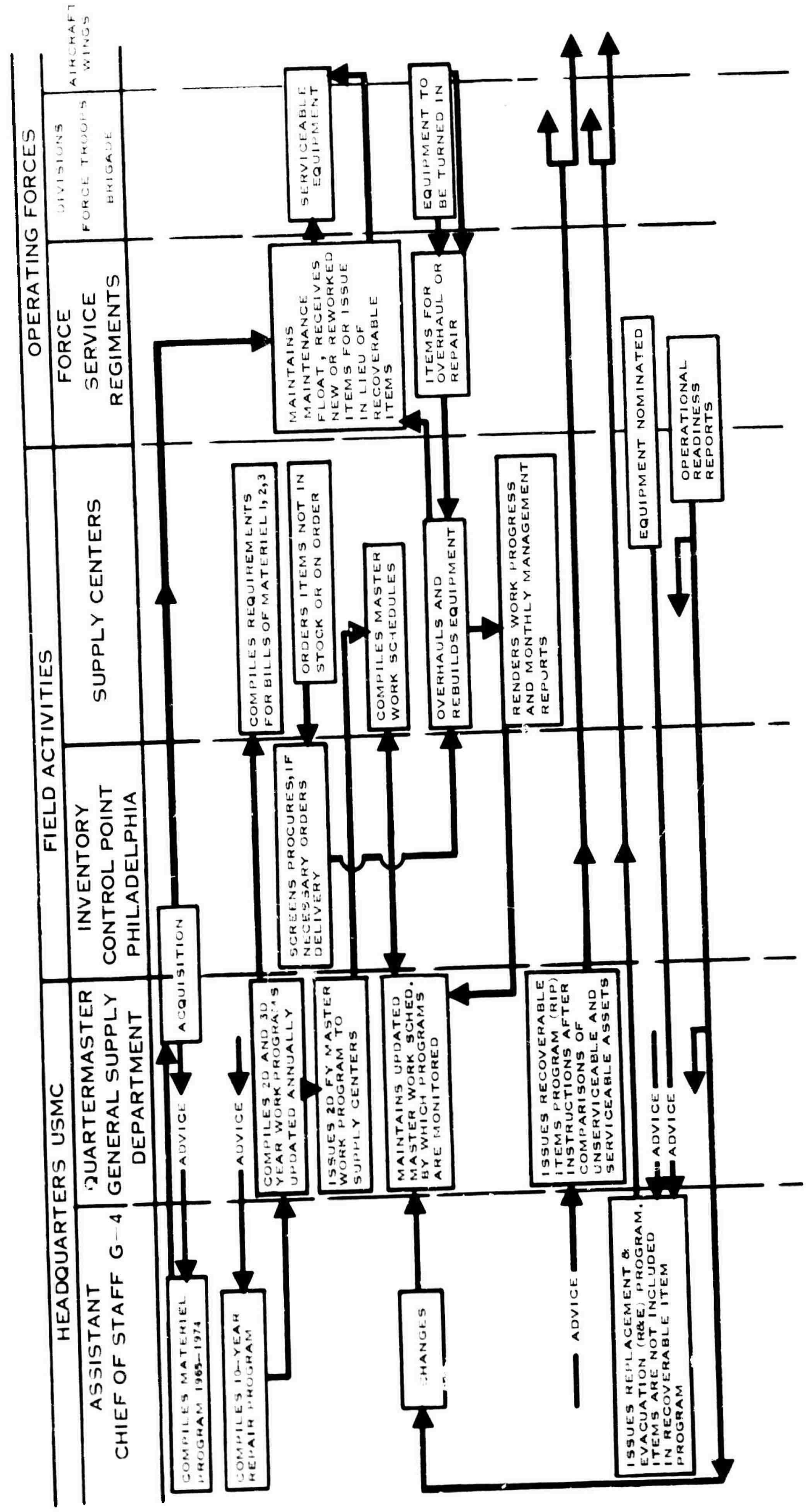

FIGURE 25. FLOW CHART OF MAINTENANCE MARINE CORPS GROUND EQUIPMENT

provided in development of joint procedures and participation in end item development projects. An example is the system program office for Tactical Information Processing and Interpretation System. The Air Force is the executive agent for this mobile, land-based information processing and interpretation system.

TABLE 25

TOTAL MARINE CORPS MILITARY MAINTENANCE PERSONNEL

	Vietnam and Western Pacific		CONUS		
Year	Officers	Enlisted	Officers	Enlisted	Total
			Ground		
1965	92	3,566	567	12,074	16,299
1966	210	7,804	442	7,965	16,421
1967	365	11,344	530	14,932	26,971
1968	329	11,912	650	31,256	49,997
1969	320	11,943	667	31,562	44,492
			Air		
1965	100	3,780	521	16,633	21,034
1966	154	6,495	385	13,662	20,696
1967	164	7,623	403	12,981	21,171
1968	164	8,011	488	13,040	21,703
1969	182	8,178	474	13,097	21,931

Source: U.S. Marine Corps, Memorandum, subject: Maintenance Personnel Data, 8 December 1969.

TABLE 26

PERCENTAGE OF MARINE CORPS MILITARY PERSONNEL IN MAINTENANCE

YEAR	MARINE CORPS	MAINTENANCE
1965	190,060	37,333 (19.5%)
1966	257,418	37,117 (14.5%)
1967	286,624	48,142 (16.8%(
1968	311,586	71,700 (23.0%)
1969	313,370	66,423 (24.6%)

TABLE 27

TOTAL MARINE CORPS CIVILIAN PERSONNEL

YEAR	WESTPAC	CONUS	TOTAL
1965	1,202	13,386	14,588
1966	7,285	14,844	22,129
1967	4,338	16,462	20,800
1968	5,506	19,091	24,597
1969	6,998	18,833	25,831

(6) The Marine Corps conducts development of certain end items at the Marine Corps Development and Education Command, Quantico, Virginia. For these projects, Headquarters, U.S. Marine Corps, determines those elements of maintenance engineering that will be considered during the development and supervises the conduct of test and evaluation. An example of an item that has been developed by the Marine Corps is the Amphibious Assault Bulk Fuel System.

(7) The Total Revision and Upgrading of Maintenance Procedures (Project TRUMP) has been a developmental program responsible for the detailed research and analysis of all Marine Corps equipment maintenance at all levels.[3] The project covered development of a maintenance concept, identification of Marine Corps equipment maintenance requirements, and maintenance management. Further development of this project will be identified as the Marine Corps Integrated Maintenance Management System (MIMMS). The objectives of MIMMS are (a) to maximize equipment readiness, (b) to ensure optimum effectiveness and efficiency in the utilization of maintenance resources, and (c) to improve the management of maintenance programs. Uniform maintenance management procedures will be employed at all levels of command. Maintenance managers will be provided with a predominantly automated information system and the other management tools requisite to proper performance of their functions. Maintenance considerations will be given due cognizance throughout the equipment life cycle in accordance with integrated logistic support principles. As MIMMS is developed, it will be closely correlated with other on-going Marine Corps systems in order to avoid redundancy in the collection, storage and reporting of information. MIMMS supports the policy that maintenance and readiness of equipment is a command responsibility.

b. Policy

(1) The Marine Corps maintenance policy is based on the principle that maintenance management is a function of command. Centralized management is vested in the commander at each level of command, and ultimately in the Commandant of the Marine Corps. The maintenance tasks to be performed on materiel are assigned to specific levels of command consistent with the primary mission, character, and mobility of the command involved. The fundamental policy provides that repair be performed at the lowest echelon of maintenance based on the nature of repair, authorized repair parts, tools and support equipment, and the skill level of personnel authorized. Materiel requiring repair which is beyond the maintenance scope or capability of one echelon is evacuated to the next higher echelon.[4]

(2) The determination of the level of maintenance repair in the Marine Corps for specific major end items of equipment, and their subsystems and components, is a continuous and repetitive logistic support process. This selection is specifically tailored to the degree and scope of Marine Corps equipment development and related to procurement actions from maintenance concept formulation through item development, production, and issue to the Fleet Marine Force. The process is being revised to pursue in greater detail the concept of integrated logistic support.[5]

(3) Marine Corps policy provides that all end items requiring repair parts support will be issued to the Fleet Marine Force with an initial issue of repair parts. The total range and quantity of items included in the initial procurement is determined by the inventory control point during the provisioning process. The initial procurement provides the using and service organizations with their initial authorized operating, mount-out and associated augmentation stocks while providing system and prepositioned war reserve stocks to support the end item. These quantities are used as the requisitioning objectives during the usage data development period, normally one year. This quantity is derived by multiplying the appropriate peace or wartime consumption rates by the density of equipment authorized which provides the Fleet Marine Force units with 30 days of supply for each of the stocks described above.

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[3] U.S. Marine Corps, Briefing, subject: Total Revision and Upgrading of Maintenance Procedures—TRUMP, Joint Logistics Review Board, 22 August 1969.
[4] U.S. Marine Corps, Paper, Maintenance Engineering, 23 July 1969.
[5] U.S. Marine Corps, Paper, Optimum Repair Levels, 25 July 1969.

(4) The Marine Corps provisioning policy objective is that 100 percent of the range and quantity of initial support items must be positioned in the appropriate segments of the supply system and maintenance echelons before new equipments are placed in service. However, when necessitated by operational considerations such as those experienced in Vietnam, the range of initial support items was reduced to include only maintenance essential spare parts; upon 100 percent positioning of the reduced range of items, the end item was placed in service.[6]

(5) While the Marine Corps officially uses the term field maintenance, its application is synonymous with the category intermediate maintenance.

c. Organization and Responsibilities

(1) Marine Corps units receive maintenance support from two sources: the Marine Corps maintenance system and the Navy maintenance system. For instance, aeronautical and other Navy-furnished materiel, including the funding thereof, required for Marine Corps aviation units, is provided the Marine Corps by the United States Navy. This latter system is reviewed in Chapter IV.

(2) Command responsibilities for the maintenance of materiel are to maintain it in a state of operational readiness, to make effective use of available personnel, equipment and supplies, and to place logistic (maintenance) support within reach of subordinate commands. Command responsibility for maintenance management is not singled out as a separate entity, but is included as an element within the broader category of logistics management. The basic structure follows two identifiable channels, both of which emanate from Headquarters, U.S. Marine Corps.

(a) The first channel is applicable to the operating forces and passes through the commanding generals of the Fleet Marine Forces to the commanding generals of Marine Corps divisions and force troops, thence to the commanding officers of combat, combat support, and combat service support units. The second channel is applicable to the supporting establishment and passes directly from the Commandant of the Marine Corps to the commanding generals of Marine Corps supply installations and Marine Corps bases, camps, and training centers.

(b) In general terms, command maintenance management related to organizational and field (intermediate) maintenance exists in both command channels. Depot maintenance management is effected almost exclusively within the supply installation element of the supporting establishment since fixed industrial type facilities are involved. Depot maintenance management is exercised by Headquarters, Marine Corps, where centralized control of depot maintenance is maintained.

(c) It should be noted that a direct command link does not exist between elements of the operating forces and the supporting establishment except at the Commandant of the Marine Corps level.

(3) The three broad categories of maintenance within the Marine Corps were redefined into echelons to provide the additional definition required to indicate more accurately the scope, mobility, and capability of a maintenance organization.

Categories	Echelons	Maintenance and Distribution of Work
Organizational	1st	May be described as proper care of equipment; performed by equipment user, wearer, or operator.
	2nd	Characterized as minor repair; performed by specially trained organizational personnel.

[6] U.S. Marine Corps, Paper, Service Supply Management, 10 October 1969.

Categories	Echelons	Maintenance and Distribution of Work
Field (Intermediate)	3rd	Characterized as component and assembly replacement; piece-part replacement performed at echelon within limitations imposed by tools, test equipment and repair parts authorized; technical assistance to lower echelons included.
	4th	Characterized as component repair; activities authorized a wider assortment of tools, test equipment, and repair parts than 3rd echelon activities; technical assistance to lower echelons also provided.
Depot	5th	Highest echelon, may be characterized as industrial maintenance; consists of overhaul, rebuild, fabrication, and manufacture; provision of technical assistance to lower echelons included.

(4) Organizationally, ground units of the Fleet Marine Forces are identified with one of two major commands, the Marine Division or Force Troops. Within these two commands units may be mission-identified as combat, combat support, or combat service support. All units have organizational maintenance responsibility, both first and second echelon, for their organic equipment. Combat service support units provide field maintenance support to third echelon within the Marine Division and to fourth echelon at the force level. Maintenance elements of combat service support units are organizationally structured to provide the necessary flexibility to accommodate the maintenance requirements of a variety of task organizations. Thus elements of division and force combat service support units may be assigned to tailor the maintenance capability of battalion-sized Marine Expeditionary Units, regiment-sized Marine Expeditionary Brigades, or to the division-sized Marine Expeditionary Force. There are significant exceptions to the performance of distinct echelons of maintenance at given levels of Marine Corps organizations. These exceptions are normally documented so that maintenance programs may be controlled.

(5) The Commandant of the Marine Corps operates two depot maintenance facilities at the Marine Corps Supply Centers, Albany, Georgia, and Barstow, California. These facilities were established for the specific mission of providing an equipment rebuild capability for support of the Fleet Marine Forces. The investment value of that portion of the Marine Corps Supply Centers tasked with fifth echelon maintenance is on 30 June 1969:[7]

	Albany	Barstow	Total
Land	$ 9,887.00	$ 1,174.83	$ 11,061.83
Buildings & Structures	6,425,811.00	5,539,269.00	11,965,080.00
Machinery & Equipment	4,256,334.00	5,442,495.00	9,698,829.00
	$10,692,032.00	$10,982,938.83	$21,674,970.83

Each centralized facility utilizes an integrated shop concept which provides a multipurpose capability and an inherent flexible capacity. They are staffed with both military and civilian personnel and equipped to perform maintenance on ordnance, automotive, and communications-electronics equipment employed by Marine Corps units. Economically reparable materiel is recovered from using units and processed through the rebuild cycle at these two locations. The Commandant of the Marine Corps repair program projects depot maintenance requirements for a 3-year period. This program provides the basis for fiscal, workload, and supply requirements

[7] U.S. Marine Corps, Memorandum, subject: Financial Data, Depot Maintenance, Joint Logistics Review Board, 7 November 1969.

projections. The program is executed on an annual basis as the master work schedule. The control and progress measurement is by the Commandant of the Marine Corps.

(a) In addition to these organic facilities, the Marine Corps utilizes the facilities of other Services, particularly the Army, through depot maintenance interservice support agreements for the rebuild or repair of materiel. Interservice support is funded through individual project orders issued and controlled by and reported to Headquarters, Marine Corps. Project orders for interservice support are financed through Headquarters, Marine Corps, controlled Operations and Maintenance (O&M) funds.

(b) The use of commercial contracts for the rehabilitation of materiel has been applied primarily to high cost, low density electronics equipment. Contractor maintenance is funded through individual contracts issued by and controlled and reported to Headquarters, Marine Corps. This contracting is performed through separately identified O&M funds at Headquarters, Marine Corps. Marine Corps Contract Maintenance description is in Table 28.[8]

TABLE 28

MARINE CORPS CONTRACT MAINTENANCE

Name and Location	Service	Quantity	Cost per Annum ($)
RCA Services Camden, N. J.	Repair and maintain radio equipment (MRC-83 & 87, PRC-47, TRC-75 & TSC-15)		130,000 est. (only 1/2 year auth.)
General Electric Co. Syracuse, N. Y.	Rebuild AN/TRQ-10	7	1,050,000
Raytheon Services Hawthorne, California	Rebuild AN/TPS-37	9	370,000
AVCO Corp. Cincinnati, Ohio	Rebuild AN/TPS-37	9	270,000
Avion Paramus, N. J.	Rebuild AN/UPS-1	20	1,050,000
Bendix Corp. Baltimore, Md.	Rebuild AN/TPS-34	6	1,800,000
Bendix Corp. Baltimore, Md.	Rebuild AN/TPS-34	9	1,800,000
Bendix Corp. Baltimore, Md.	Rebuild AN/TPS-22	4	880,000
Raytheon Services Hawthorne, California	Rebuild AN/TPS-22	9	1,980,000
Admiral Systems Chicago, Illinois	Rebuild AN/TPS-28	145	221,875
RCA Services Camden, N. J.	Rebuild AN/TRC-97	10	1,009,300

Note: Dollar figures provided are total dollars for the contract and represent total funds provided for a contract to rebuild a certain number of items, including costs of material as well as labor.

[8] Ibid.

(6) Like the maintenance system for Marine Corps supported equipment, aeronautical maintenance operations were assigned to specific levels of command consistent with the assigned unit's primary mission, character, and mobility. Aeronautical maintenance for Marine Corps aviation was grouped into three categories: organizational, intermediate, and depot.

(7) Basic policies and concepts for aeronautical maintenance are established by the Chief of Naval Operations. Organizational level maintenance is performed in the operating squadrons and intermediate level in the Headquarters and Maintenance Squadron of the Marine Aircraft Group. Basically, the Headquarters and Maintenance Squadron of the Marine Aircraft Group is comparable to the Navy aircraft maintenance department of the aircraft carrier or the naval air station. However, it differs in the respect that Headquarters and Maintenance Squadron equipment must be capable of rapid relocation and operation in an expeditionary environment. The intermediate maintenance capability of the Headquarters and Maintenance Squadron moves with the parent Marine Aircraft Group, while the Navy carrier air wing was alternately supported by the aircraft maintenance department of the ship or the naval air station, depending upon deployment status.

(8) Depot level maintenance is not organic to the Fleet Marine Forces. Depot level maintenance support was performed at designated overhaul points. These may have been either naval aircraft rework facilities, facilities of other military services, or commercial activities.

(9) Beginning in FY 65 the Standard Navy Maintenance and Material Management (3M) system was phased into Marine aviation units at Marine Corps Air Station, Cherry Point, N.C.

d. Maintenance Management

(1) The Marine Corps Maintenance Management System, as currently established, does not differentiate between commodity areas (i.e., Motor Transport, Communications, Electronics, Engineer, Ordnance, and General Supply). Therefore, the material presented is equally applicable to all commodity areas unless a specific variation is noted.

(2) The distribution of maintenance effort is as follows:

(a) Operating Forces (Fleet Marine Force). The maintenance workload in the operating forces is divided into four echelons, first through fourth.

(b) Depot Maintenance Activity. Fifth echelon maintenance is performed at the Marine Corps supply Centers.

(c) Controls and Constraints. The maintenance performed within each echelon is controlled through the allocation of personnel, test and support equipment, and repair parts. The allocation of maintenance personnel is by means of a Table of Organization (T/O). T/Os provide authorized billets for each organization in the Marine Corps. These billets are described by Military Occupational Specialty (MOS). The T/O also indicates the echelon of maintenance that is authorized to be performed by the organization. Tools and test equipment with which to perform the maintenance tasks, as well as other organizational equipment, are allocated on the basis of the organization's Table of Equipment (T/E). The Marine Corps Stock List (SL-4) provides a Source, Maintenance and Recoverability (SMR) Code for most components and repair parts in the Marine Corps inventory. Among other things, the SMR code indicates the lowest echelon of maintenance capable of installing that item in an equipment. The SL-4 also designates the maintenance echelon at which the item may be stocked. Thus, the T/O, T/E, and SMR code constrain the amount of maintenance that may be performed at each echelon.[9]

[9] U.S. Marine Corps, Briefing, subject: Marine Corps Maintenance Management System, 7 May 1969.

(d) Maintenance Techniques. Several techniques and methodologies characterize all maintenance operations in the Marine Corps. The most significant ones are described below:

1. Using units perform their authorized echelon of maintenance on a "repair and use" basis. Equipment requiring maintenance beyond the using unit's capability is evacuated to support maintenance activities for the necessary repairs.

2. Support maintenance activities perform their authorized echelons of maintenance on a repair-and-return-to-user or stock basis. Except when priorities require otherwise, maintenance is accomplished on the principle of "first come, first served." Support maintenance activities maintain and control a float of selected end items and components which are used to augment the repair capability of the support shop to replace unserviceable like items in the float, as required to meet operational commitments or in cases of emergency. The decision to repair or replace, however, is made by the support activity rather than by the using unit.

3. Stocks of repair parts are under the control of appropriate supply activities. However, stocks of repair parts are positioned within the support maintenance activities in order to allow the maintenance activities easier access to the necessary repair parts. Such stocks are called shop stores.

4. Maintenance by cannibalization (the removal of serviceable parts from one item of equipment for use in repairing another item of equipment) is not employed by the Marine Corps except in extremely urgent cases under combat conditions, as authorized by the Fleet Marine Force commanders and in other cases as specifically authorized by Headquarters, U.S. Marine Corps.

5. First through fourth echelon maintenance is generally performed on an as-required basis—that is, maintenance (other than preventive maintenance) performed at these echelons is normally not scheduled, but is performed whenever needed. Fifth echelon maintenance is always scheduled.

(e) Marine Corps aviation units except for aeronautical materiel operate, maintain, and obtain maintenance or Navy-furnished materiel in accordance with Navy maintenance policy and procedures. Navy/Marine Distribution of Work in Fleet Marine Force Aviation is the Marine Aircraft Wing which has an organic capability to perform first through fourth echelon maintenance on Navy-furnished items of ground equipment. However, in the case of Marine Corps-furnished equipment, the Marine Aircraft Wing, like the Marine Division, performs only first through third echelons. The Force Service Regiment is in direct support of the Division/Wing team and provides fourth echelon maintenance support for both on Marine Corps-furnished equipment.

e. Relationship of organizational to depot level maintenance. The link between organizational level of depot level maintenance is effected principally through three programs. First, the Replacement and Evacuation Program[10] provides for the replacement of major end items of equipment in the hands of using units with new or rebuilt (like new) items followed by the evacuation of similar economically reparable equipment in the poorest mechanical condition or with the least remaining combat serviceable life to the supply centers for rebuild. Annually, a percentage of equipment in the T/E of the Fleet Marine Force units is replaced. The second program is the Recoverable Items Program.[11] The purpose of this program is to ensure that major end items are either recovered/evacuated or disposed of based on the condition of the materiel and/or the asset position of the Marine Corps. The program covers designated recoverable items which cannot be repaired within the resources available to the field commander or which become excess to a commander's allowance. The Recoverable Item Program provides for the return of major end items to fourth and fifth echelon maintenance activities when

[10] U.S. Marine Corps, Special Programs Manual (MCOP4400.84), May 18, 1967.
[11] U.S. Marine Corps. Marine Corps Recoverable Items Program (MCO4400.4F), December 31, 1968.

inspection indicates that they require repair/rebuild at either level. The third program is the maintenance float[12] for third and fourth echelon facilities which provides a pool of end items for indirect exchange. The maintenance float permits the replacement of entire components and in certain cases, where operational readiness dictates, an entire end item can also be replaced. Normally, a replacement end item will be issued in exchange for an unserviceable item which cannot be repaired in 30 days. The unserviceable float items are then repaired and the float reconstituted.

f. Personnel and Training

(1) Personnel. Allocation of maintenance personnel resources is provided by the Unit Table of Organization. The T/O establishes the basic mission of the unit concerned and defines its maintenance capability. Having established the task, billets are identified which authorize allowances of personnel to perform the task. A military occupational specialty code number assigned to the billet indicates the skills required of the individual Marine to perform the duties of that billet. Each maintenance related military occupational specialty is monitored by a technical sponsor at Headquarters, U.S. Marine Corps who is responsible for the identification of training requirements to achieve the required skills and to ensure that necessary adjustments are made to meet new requirements.

(2) Training. Maintenance training requirements are met both by internal Marine Corps effort as well as significant participation in management and technical courses offered by other Services or commercially. On completion of the requisite training the individual Marine is assigned the appropriate military occupational specialty which identifies the skill level he has attained. Training conducted by the depot maintenance activities includes formal classroom work as well as on the job training to develop and maintain proficiency levels in maintenance skills of civilian and military personnel in their technical specialties.

2. MAINTENANCE SUPPORT DURING THE VIETNAM ERA

a. General

(1) On 1 January 1965, Marine Corps forces received maintenance support through both the Marine Corps maintenance system and the Navy maintenance system. This combination provided satisfactory support. Fleet Marine Force units, both air and ground, employed hand manual procedures for record keeping and requisitioning parts and end items. For deployed units and forces serving in the Western Pacific area, the pipeline was long and oriented toward peacetime standards and fiscal constraints. The task organization of units continued to provide the most reliable means of effecting repairs in an expeditionary environment in keeping with missions assigned the operating forces.[13]

(2) Density of maintenance float equipment and other maintenance resources were included in the pipeline and turnaround time based on peacetime requirements.[14]

(3) The maintenance reporting system for equipment readiness was based on selected major items of equipment considered essential to the conduct of the combat mission, including training for that mission, of the unit holding the equipment. While the number of major line items reported on (175) was relatively limited as compared to present reporting requirements (388), reports provided an index of how the maintenance system was performing. Based on reporting requirements for combat essential equipment, the performance of the maintenance system in January 1965 was adequate for the employment and environment in which the Marine Corps found itself.[15]

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[12] U.S. Marine Corps, Maintenance Float 3d-4th Echelon Maintenance (MCO 4000.6), 19 January 1961.
[13] U.S. Marine Corps, Paper, Logistic Posture of USMC at Start of the Vietnam Buildup, 6 June 1969.
[14] Ibid.
[15] Ibid.

(4) The logistic support of the Fleet Marine Forces in the Pacific Command was initially accomplished through the integral organization of two divisions and two aircraft wings, specialized support units and the 3d Force Service Regiment on Okinawa. Subsequently, the 1st Force Service Regiment at Camp Pendleton, California was used for augmentation.

(5) Figure 26 and Table 29 depict the flow and maintenance efforts of both new and rebuilt items to RVN as well as retrograde of reparable equipment to Western Pacific rebuild facilities and CONUS supply centers.

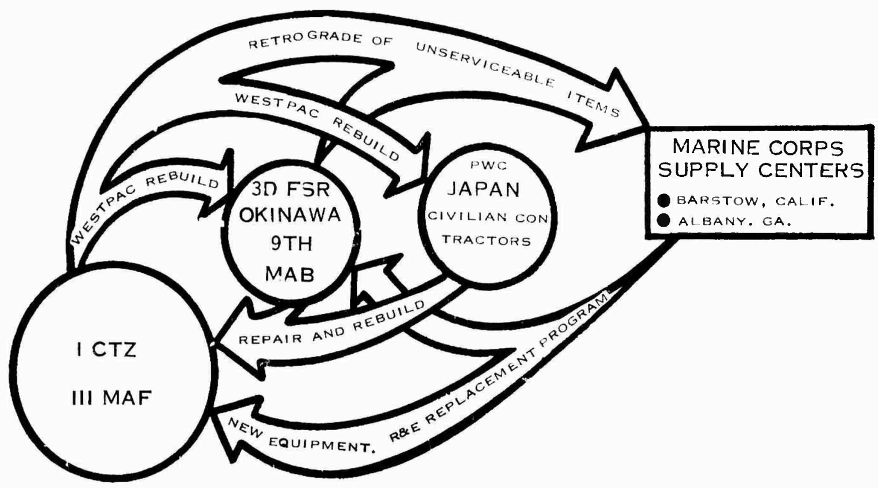

FIGURE 26. FLOW OF EQUIPMENT TO AND FROM RVN

TABLE 29

DISPOSITION OF RVN EQUIPMENT REQUIRING REPAIR

Action	CALENDAR YEAR			
	1965*	1966	1967	1968
Items evacuated from RVN to Okinawa (3d FSR)	3,180	16,532	26,488	18,650
Items repaired at 3d FSR	3,231	14,352	86,127**	36,355
Items returned to CONUS or disposed on Okinawa	2,275	6,108	5,659	2,190

*August through December.
**Reflects rehabilitation of the Battalion Landing Team, Special Landing Force. This equipment is considered in support of RVN.

b. In-Country

(1) The Marine Corps concept of logistic support in RVN was to provide centralized control of supplies and services for all forces while maintaining the maximum degree of flexibility and mobility of forces and retain an amphibious capability. The Marine Corps buildup began with the deployment of forces to Da Nang beginning 8 March 1965, which set a logistic pattern which was followed in deployment. The initial maintenance concept for Fleet Marine Force ground units provided for first through third echelon in-country; fourth echelon at the 3d Force

Regiment on Okinawa; all depot, or fifth echelon, in the United States.[16] In execution of this concept, a logistical task organization made up of supply, maintenance and service elements of the Headquarters Battalion, Medical Battalion, Dental Battalion, and Motor Transport Battalion, 3d Marine Division; 9th Motor Transport Battalion; and 3d Force Service Regiment landed at Da Nang to provide the initial support of deployed Marine Corps forces. During the first sixty days there were no significant logistic deficiencies. By 7 May 1965, the force buildup began and additional aviation units were introduced in-country. At this time a Marine Corps expeditionary airfield was constructed at Chu Lai, becoming operational on 1 June 1965. Although the forces ashore were eight times the original strength, and adverse weather conditions prevailed, the maintenance of equipment during 1965 barely kept pace with the requirements. One difficulty experienced in RVN with regard to buildup of maintenance support was the slow development of facilities to support the performance of the higher echelons of maintenance in-country.[17]

(2) By Marine Corps concept, maintenance support through the fourth echelon is deployed with adequate resources to perform the mission. Conditions in-country hampered the rapid establishment of fourth echelon maintenance capability after the initial landings. Because of the presence of standing or running water over long periods of time during the monsoons, soil conditions were too unstable to permit the establishment of the degree of cleanliness required when equipment is disassembled for repair. During dry periods, the maintenance tent is not impervious to dust accumulation to an acceptable level.[18]

(3) By the end of 1965, due to the implementation of the special assistance measures (maintenance teams and expediting supply actions), improved maintenance practices, replacement of unserviceable vehicles and increased pipeline supply support, the percentage of deadlined combat essential equipment had decreased from 25 percent in September 1965 to an overall 12.5 percent. The equipment deadline rate is an important indicator of overall logistic performance. It indicates that portion of on-hand combat essential equipment which is out of commission, either in need of maintenance or lack of repair parts. There is implicit in the deadline rate not only a measure of maintenance effectiveness but also a reflection of the supply system performance, the adequacy of manpower, the degree of training and overall logistics management. The deadlined equipment rate assesses performance of the logistic system as seen by the user. The equipment deadline rates for the years 1965-1968 are reflected in Table 30.[19]

TABLE 30

AVERAGE DEADLINE RATES (PERCENT) FOR EQUIPMENT IN RVN

Category	1965*	1966	1967	1968
Communications-Electronics	NA	9	8	14
Ordnance		3	2	14.5
Motor Transport	NA	8	7	13
Engineer		21	11	30
General Supply	NA	3	4	1
Composite	12.5	9	7	17**

(NA - Not Available)

*September-December.
**A change in method of calculation on 1 July 1968, and reporting under the Marine Corps Automated Readiness Evaluation System. Previously, the deadline rate was based on equipment deadlined in excess of 24 hours. While the rates appear to have increased considerably, the number of deadlined items remained essentially at the same level as in 1967.

16 U.S. Marine Corps, Memorandum, subject: Maintenance Engineering, 5 September 1969.
17 U.S. Marine Corps, Compendium of Logistic Support Experiences in RVN, June 1966.
18 Ibid.
19 U.S. Marine Corps, Fleet Marine Force, Pacific, Southeast Asia Operations 1965-1968.

(4) In January 1966, the demands for maintenance continued and reliance remained on the special supply programs Red Ball and CRITICPAC, plus premium transportation to keep the lead times for critical items at a minimum and to maintain an acceptable state of materiel readiness.[20] In March 1966, action was initiated to increase the fourth and fifth echelon maintenance capabilities in-country and offshore, both organically and through expanded use of inter-service support agreements. The 3d Force Service Regiment, Okinawa, performed some fifth echelon maintenance and increased fourth echelon work was performed by Force Logistics Command in RVN. By September 1966, the Force Logistics Command was the major support element for all Marine Corps Forces in RVN. It was built around a central headquarters which employed advanced accounting techniques and mechanization to control the commitments of material and services to meet III MAF requirements.[21]

(5) During the year, an intensified rehabilitation and rebuild program was developed offshore which was designed to maximize use of available assets and programs and to ensure the highest level of equipment readiness. The program remained based on the Headquarters, Marine Corps, controlled Replacement and Evacuation Program. The expansion provided repair of motor transport and engineer equipment in Japan by the Navy Public Works Center and civilian contractors; expansion to a limited depot capability (5th echelon) in the 3d Force Service Regiment on Okinawa; and, a special program to expedite amphibious tractors to and from CONUS. This period also marked the introduction of a new family of radios which further assisted in communications-electronics equipment availability and reduced the deadline rates. The maintenance system demonstrated its capability to provide continued support for extended operations in underdeveloped regions.[22]

(6) By January 1967, the data processing capability was increased by the installation of the IBM 360 computer which permitted a more sophisticated and expanded inventory control and equipment status reporting. Consequently this control system, managed by the Force Logistics Command provided a continuous data base at all Marine Corps logistics activities under its command for problem oriented management. This permitted better distribution of assets among all support areas. Logistics data are also interchanged daily between the Force Logistics Command and Marine Corps offshore logistic support (3d Force Service Regiment) on Okinawa. This latter command, in turn, provided logistic data to the inventory control point, the Marine Corps Supply Activity, Philadelphia, Pa.[23]

(7) By mid-1967, the two Marine HAWK missile battalions were authorized an increased capability for maintenance by expansion of the range and depth of repair parts due to the low density of end items, high cost and wide range of parts. Also, in this same time frame, certain end items of Marine Corps Aviation ground support equipment to be rebuilt or repaired were added to the overall Fleet Marine Force Pacific rebuild program.[24]

(8) The effort in 1967 was characterized by stability and concentration on improved organization and management of maintenance. The corresponding downward trend in the equipment deadline rate in the Western Pacific was also attributable to the major maintenance activity of the tactical equipment repair orders.[25]

(9) In January 1968, the deteriorating effects of the climate became increasingly noticeable by the rising number of major items on deadline. A program was established for the Force Logistic Command to transfer major end items on deadline over 60 days to 3d FSR (Okinawa) thereby permitting FLC to concentrate on repair of items for which repair parts were available.[26]

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[20] U.S. Marine Corps, Fleet Marine Force Pacific, Southeast Asia Operations, 1966.
[21] Ibid.
[22] Ibid.
[23] U.S. Marine Corps, Report, Fleet Marine Force Pacific Southeast Asia Operations, 1967.
[24] Ibid.
[25] Ibid.
[26] U.S. Marine Corps, Report, Fleet Marine Force Pacific Southeast Asia Operations, 1968.

(10) By October 1968, Marine Corps commanders in RVN were provided a means of accelerated management action on urgently needed combat essential items, by an automated procedure called the Marine Corps Automated Readiness Evaluation System (MARES). Communication equipment maintenance in-country was expanded by the authorization to perform fourth echelon on the AN/TRC-97 at the Force Logistics Command. It is estimated that the establishment of this facility reduced, by approximately 50 percent, the number of modules requiring evacuation to CONUS for fourth echelon repair at the factory and, as the maintenance capability matured, the necessity for fourth echelon evacuation was removed. Another program was the acquisition of assets to increase direct exchange for teletype components which reduced the out-of-service delays.[27]

(11) In 1968 the maintenance system responded to the demands and remained responsive in support of the combat forces. Improved balance of maintenance effort WESTPAC and the vigorous application of first echelon maintenance were the contributing factors. The accomplishments of the system can be evaluated by an analysis of the 1967-1968 maintenance efforts of the two prime organizations, Force Logistics Command and 3d Force Service Regiment. The total Tactical Equipment Repair Orders (TEROs) increased 24 percent from 1967 to 1968. A total of 134,942 TEROs were initiated in 1967, of which 132,222 were completed; during 1968, 164,027 TEROs were initiated and 164,881 were completed.[28]

(12) In keeping with plans to completely modernize the Marine Corps tactical vehicle inventory in WESTPAC, new equipment and replacement vehicles arrived in-country during 1968. Notable among these replacements were the multifuel family of 2-1/2 and 5-ton tactical vehicles, the new M151 1/4-ton jeep, and the 10-ton truck tractor received by III MAF units during 1968.[29]

(13) The end item maintenance float which provides for direct exchange of selected end items of equipment when repairs can not be accomplished to meet time frames for operational commitments or within 30 days was hampered by inadequate assets and affected the equipment deadline rates. The progress made in completing the authorized allowance was from 35 percent in September 1968 to over 80 percent by August 1969. The expansion of the maintenance float of certain equipment has been effective in supporting out-of-country maintenance programs and been significant in reducing the deadline rate.[30]

c. Offshore

(1) The Third Force Service Regiment (3d FSR), Okinawa, experienced an expansion of its maintenance functions, both in capability and capacity. The maintenance mission is executed by the Maintenance Battalion. Its organization and strength are reflected in Figure 27. Although not a true measure since items vary in size and time to repair, the basic indicator of work is the TERO. The production of TEROs from 1965 to 1969 is shown in Figure 28.[31] The quantity of equipment received was greatly increased as the repair/rebuild and maintenance balance programs were implemented. Although the total number of Tactical Equipment Repair Orders received lessened during 1968, the workload increased due to the number of major end items involved, most of which required extensive repair.

(2) Since timely production statistics for maintenance management and control were required, an automated record keeping system was instituted called Automated Reporting Maintenance System (ARMS). This system provides daily data that are used for the improvement of overall maintenance management. It is primarily designed to provide timely and accurate information pertaining to equipment undergoing repair in the 3d Force Service Regiment. In addition, it records other information closely related to the maintenance effort such as materiel requirements information and manpower availability and utilization.

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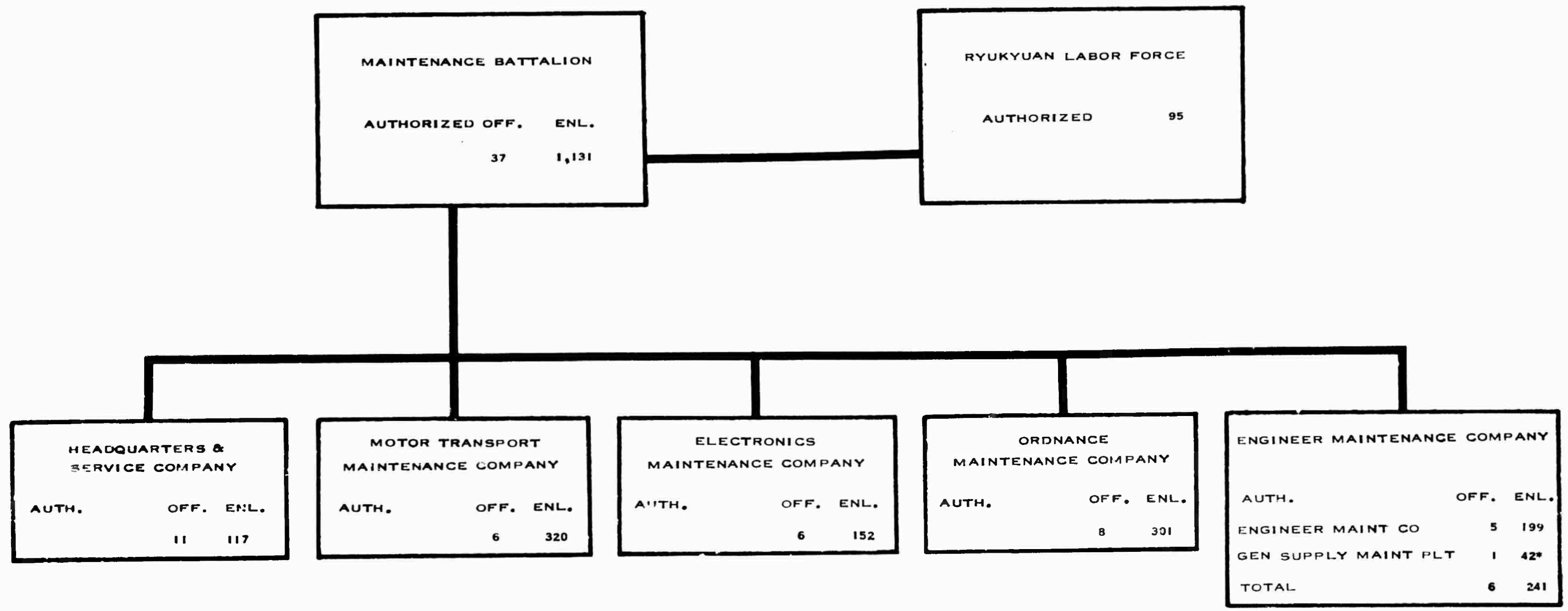
[27] Ibid.
[28] Ibid.
[29] Ibid.
[30] U.S. Marine Corps Presentation Force Logistics Command, Fleet Marine Force Pacific, to Joint Logistics Review Board, 15 September 1969.
[31] U.S. Marine Corps Briefing Headquarters, Third Force Service Regiment to Department of Defense Joint Logistics Review Board, 18 September 1969.



NOTE:
THE 3D FSR STRENGTH (MARINES AND NAVY) ON 2 DECEMBER 1966 WAS 148 OFFICERS AND 3,712 ENLISTED.

* GENERAL SUPPLY MAINTENANCE COMPANY REDUCED TO PLATOON SIZE AND PLACED UNDER ENGINEER MAINT CO.

FIGURE 27. ORGANIZATIONAL CHART, MAINTENANCE BATTALION 3d FORCE SERVICE REGIMENT
(2 DECEMBER 1966)

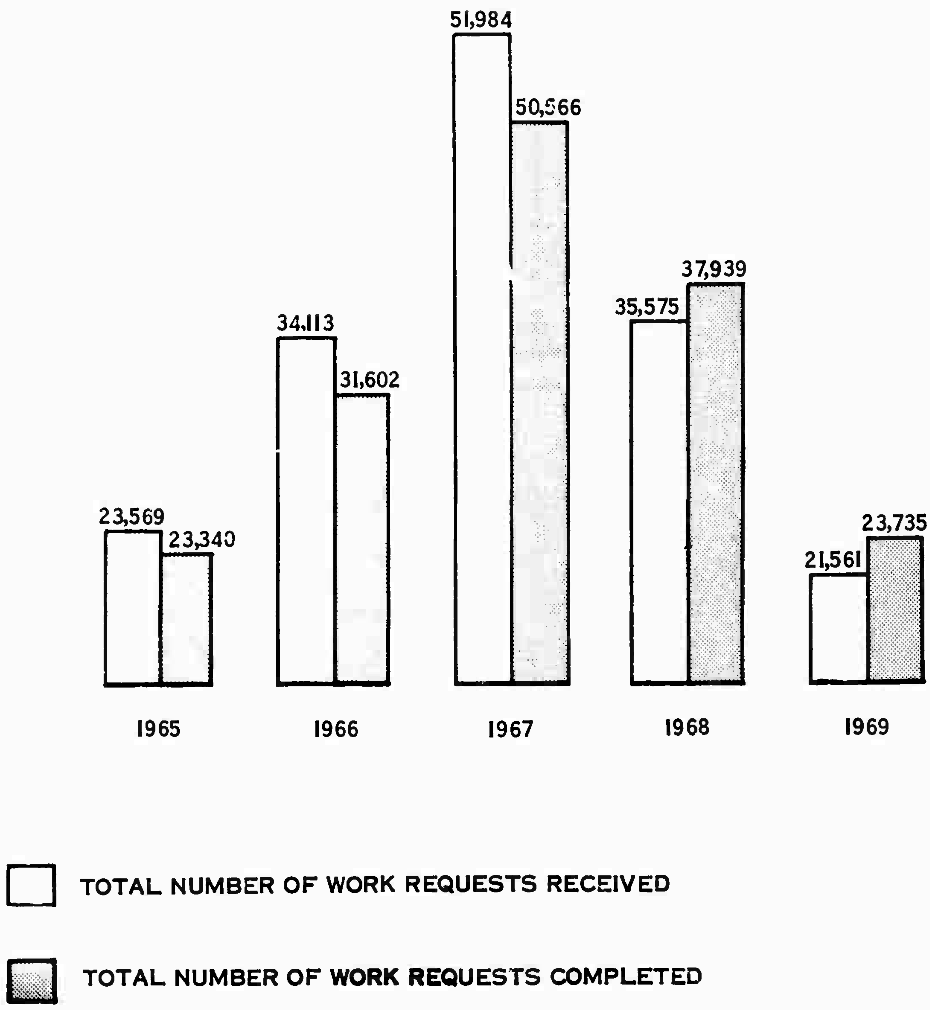


FIGURE 28. TACTICAL EQUIPMENT REPAIR ORDERS PRODUCTION, 3d FORCE SERVICE REGIMENT

(3) In 1969, the special program for rehabilitating the equipment of the Seventh Fleet Special Landing Force, 9th MAB, was transferred from Subic Bay, where it had been since 1967, to the 3d FSR, Okinawa. The return to use of the direct organic capability of the 3d FSR under the original concept provided a greater depth of skills, supply support, maintenance capability, and expeditious completion of required work.

(4) The Fleet Marine Forces, Pacific (FMFPAC) Equipment Rebuild Program included items organic to Marine Corps ground forces as well as tactical vehicles from the Marine Aircraft Wing. The workload is distributed among six facilities: Third Force Service Regiment, Okinawa; 2d Logistical Command, U.S. Army, Okinawa; Public Works Center, Yokosuka, Japan; Public Works Center, San Diego, California; Marine Corps Air Station, El Toro, California; and, the Naval Construction Battalion Center, Port Hueneme, California. The review herein is directed to the support provided in Okinawa and Japan. Table 31 shows the complete program.[32]

[32] U.S. Marine Corps, Memorandum, subject: Depot Maintenance Workload and Personnel Data (JLRB-FLF-rcr), 14 January 1970.

TABLE 31

FLEET MARINE FORCES, PACIFIC, REBUILD PROGRAM
(ITEMS OF EQUIPMENT)

Facility	FY 66	FY 67	FY 68	FY 69	FY 70	Total
3d Force Service Regiment, Okinawa	1	131	288	321	121	862
2d Logistical Command, Okinawa				56	391	447
Public Works Center, Yokosuka	28	298	462	272	314	1,374
Public Works Center, San Diego					19	19
Marine Corps Air Station, El Toro					2	2
Construction Battalion Center, Port Hueneme			26	22	63	111
Total	29	429	776	671	910	2,815

Note: Actual completions in FY 66-69. Projected completions through November 1970 for FY 70.

(a) The FY 69 rebuild program contained approximately 51 different types of USMC and USN equipment.

(b) The FY 68 program had approximately 89 different types of items. Problems during FY 68 were primarily caused by inadequate availability of repair parts and technical manuals.

(5) Third Force Service Regiment, as FMFPAC's control agency for the repair/rebuild effort in WESTPAC, applied the following criteria to those equipments nominated by FLC for induction into the program:

(a) The item must have a high deadline rate, and must be in critically short supply in South Vietnam.

(b) The item will require minimum time in the repair/rebuild cycle.

(c) A replacement for the item is not available, or has not been programmed.

(6) In execution of its function as program manager, 3d FSR's Repair/Rebuild Control Center performed the following tasks:

(a) Maintained data of the current capabilities of those facilities providing maintenance support to WESTPAC units.

(b) Designated the facility to which an item will be shipped for repair/rebuild.

(c) Arranged for shipment of all items to and from the repair facilities.

(d) Determined the reparability of all items, in accordance with stated repair criteria.

(7) To attain closer alignment with the annual fiscal planning cycle the program shifted, in January 1968, from a quarterly forecast plan of implementation to a fiscal year schedule of implementation. Through the use of equipment combat utilization experience factors, the fiscal year plan, nevertheless, has built-in safeguards which allow for the introduction into the program, at any time, of unprogrammed items suddenly critical due to combat use.

(8) The expansion of shop space for the 3d FSR greatly increased the output, as shown in Table 32.

TABLE 32

EXPANSION OF COVERED MAINTENANCE SHOP SPACE
(SQUARE FEET)

Shop	1 April 1965	1 July 1969
General Supply	2,000	19,800
Electronics	7,500	11,300
Engineer	10,000	48,800
Motor Transport	10,500	67,400
Ordnance	12,000	52,700
Total	42,000	200,000

Source: U.S. Marine Corps, Memorandum, subject: Maintenance Workload and Personnel Data (JLRB-FLF-rcr), 14 January 1970.

(9) The providing of contract maintenance teams for RVN support consistently required in excess of 2,000 man-hours per month.[33]

(10) The third and fourth echelon maintenance capability was constrained by long lead time repair parts, inadequate in-depth secondary reparable assets and imbalances in personnel strengths.[34]

(11) The 3d Force Service Regiment experienced a steady rise in workload from July 1966 through April 1967. At this time, the maintenance programs began to stabilize with improved management of retrograde items from RVN, equipment arriving on a scheduled basis, shipments being of manageable size, and better coding for repair determination.[35]

d. Continental United States

(1) The logistics mission of the supply centers includes repair and manufacturing when authorized by the Commandant of the Marine Corps. Prior to 1967, the mission was based on an east coast and west coast complex, although there were cross-referral actions for total Marine Corps support.

(2) In 1965, requirements were set forth for increased support to the forces in Vietnam, expanded activity within CONUS, and large scale preparations for a virtually new supply system for the Marine Corps. These latter preparations included planning, procedure

[33] Ibid.
[34] Ibid.
[35] Ibid.

writing, and the training of personnel. The Vietnam conflict precipitated a vastly increased amount of activity for the supply centers. Much of the increase was absorbed in the normal conduct of work, but the pressures of high priorities and unforeseen requirements demanded the initiation of special efforts and resourcefulness to be more responsive to the Fleet Marine Forces. All major operational objectives were met and the depot maintenance posture was excellent.

(3) Also during 1965, the supply centers were directed to convert a specified number of military billets to civilian positions in response to the DOD civilianization program.[36] The Office of Secretary of Defense Civilianization Program had a favorable, but slight, impact on the Depot Maintenance Activities' as the result of the improved ratio of production hours to available man-hours. This impact was slight for two reasons. At the time the Office of Secretary of Defense Civilianization Program was effected, the repair divisions of the supply centers were already essentially civilianized. Secondly, although some hard skill billets were civilianized, they were not all filled because of the depot maintenance activities rather remote locations away from the proximity of a large labor force. Therefore, skill availability was not appreciably increased.

(4) The impact on the depot maintenance facilities in the 1966-to-1968 period ranged from increased production schedules to a high throughput of military personnel, both causing continuing adjustments to their operating plans. Consequently, the available work force would not balance to the assigned workload in a manner to maximize production. The average employment level is noted in Table 33.

TABLE 33

DEPOT MAINTENANCE ACTIVITY, AVERAGE EMPLOYMENT LEVEL

Work Force	FY 65	FY 66	FY 67	FY 68	FY 69
			Albany		
Civilian	673	728	857	774	720
Military	217[1]	217[1]	433[1,2]	433[1,2]	204
			Barstow		
Civilian	763	842	1,011	948	852
Military	204[1]	204[1]	381[1,3]	381[1,3]	215

[1]Actual average employment level not available; figure represents personnel authorized by Tables of Organization (T/O).
[2]Includes SE Asia augmentation T/O of 216 military; however, actual military attached averaged approximately 240.
[3]Includes SE Asia augmentation T/O of 177 military; however, actual military attached averaged approximately 210.

Source: U.S. Marine Corps, Memorandum, subject: Depot Maintenance Workload and Personnel Data, 14 January 1970.

[36]U.S. Marine Corps, Memorandum, subject: Maintenance Workload and Personnel Data (JLRB-FLF-rcr), 14 January 1970.

(5) Augmentation of personnel was provided in connection with SE Asia.[37] In order to determine the augmentation personnel required by each depot maintenance activity, it was necessary to establish a base figure. This figure was determined over a 12-month period, July 1964 through June 1965, resulting in an average number of personnel aboard prior to the increased commitment in SE Asia. The civilian count for this period is actual and the military is as specified by the T/O. The base figure is 877 civilian and military at the Depot Maintenance Activity, Albany and 980 civilian and military at the Depot Maintenance Activity, Barstow. Augmentation of personnel was determined by using the base figure stated above and the average employment level shown in Table 33. Augmentation totals were:

Activity	FY 65	FY 66	FY 67	FY 68	FY 69
Albany	13	68	413	330	47
Barstow	0	66	412	349	87
Total	13	134	825	679	134

(6) The Marine Corps Organic 5th Echelon Repair program is shown in Table 34.

TABLE 34

MARINE CORPS ORGANIC ANNUAL 5th ECHELON REPAIR PROGRAM

Fiscal Year	Engineer		Communications-Electronics		Ordnance-Tank-Automotive	
	Principal	Secondary	Principal	Secondary	Principal	Secondary
1966	39	82	205	1585	765	32073
1967	53	152	208	1589	626	18532
1968	23	367	277	795	801	24440
1969	34	406	96	817	914	12590

Source: U.S. Marine Corps, Memorandum, subject: Depot Maintenance Workload and Personnel Data, 14 January 1970.

(7) During FY 66, Depot Maintenance Activity Albany, processed 3,542 shipment work requests involving 29,400 items of equipment. Major items were shipped at a rate of 14 each day (compared to 11 each day during FY 65) and minor items at a rate of 114 each day (compared to 97 each day during FY 65). Significant observations concerning the depot maintenance activity's workload for FY 66 are: preparation of major items for shipment increased 65 percent over FY 65; the numbers of equipments contained in the Master Work Schedule increased 47 percent over FY 65; productive man-hours increased 26 percent over FY 65; and the cost of the repair program increased approximately 86 percent.[38]

(8) At Depot Maintenance Activity, Barstow, the increased production schedules were largely met. To achieve this, personnel worked extensive overtime in some areas and went into two shift operations in others. The lengthening of the work week placed serious demands upon production machinery, and required augmentation to the maintenance work force in order to maintain machinery, thereby preventing costly breakdowns. During the last 6 months of

[37] U.S. Marine Corps, Memorandum, subject: Depot Maintenance Workload and Personnel Data, 14 January 1970.

[38] U.S. Marine Corps, Command Chronology, Marine Corps Supply Center, Albany, Georgia, June 1966.

FY 65, this depot maintenance activity used 176,745 military productive hours at a total cost of $327,317. Civilian productive hours were 545,036 at a cost of $2,423,099. Military support man-hours were 220,930, costing $512,398, combined with a civilian effort of 383,461 support hours, costing $1,781,734.[39]

(9) In FY 69 the Marine Corps Supply Centers, Albany and Barstow, were chartered by the Department of Defense under the Marine Corps Industrial Fund and provided a cash corpus (Albany, $2,000,000; Barstow, $2,600,005) to commence operations. Project Orders were issued from Headquarters, Marine Corps, for financing and controlling the depot maintenance effort performed under the Headquarters Marine Corps controlled Master Work Schedule. Each supply center is required to report to Headquarters Marine Corps on a monthly basis for work accomplished against the Headquarters, Marine Corps, Project Orders. Additionally, each supply center is required to submit detailed financial and management type reports on both a monthly and quarterly basis.[40] There was no recognized change in depot maintenance effectiveness by this change in financial management. An analysis of the Marine Corps Industrial Fund is presented in Table 35.[41]

(10) The financial support required for the total depot maintenance effort is depicted in Table 36, FY 65-69.[42] Premised on FY 65 being representative of an average pre-Vietnam year, it could be concluded that CONUS maintenance support relative to the Vietnam effort cost $8.1 million, $11.2 million, $8.3 million, and $17.6 million for FYs 66, 67, 48, and 69, respectively.

(11) There were several special efforts made which will describe the manner in which the Supply Centers approached their mission, and illustrate the resourcefulness with which they pursued this task.

(a) The OTTER Program[43]

1. On 25 August 1965, the Commandant of the Marine Corps advised the Marine Corps Supply Center, Barstow, that there was an FMFPAC requirement for the M-76 Amphibious Vehicle, known as the OTTER. The requirement was for 33 vehicles, with necessary spares to support the vehicles for 60 days in operational status.

2. The OTTER is a highly useful piece of equipment for amphibious operations. The rainy season in Vietnam created such conditions that amphibious vehicles were frequently more useful than wheeled vehicles for many ground operations. This situation made the FMFPAC request for OTTER an urgent one. While the OTTER is a useful piece of equipment, it is also a highly individualistic piece of equipment requiring tune-up with each 1,000 feet change in elevation. The problem was compounded by the fact that the item was long out of production, which created a spare parts problem.

3. The rehabilitation and testing program on the OTTERs was initiated by late August 1965, and moved swiftly forward. Problems other than spare parts encountered were in the transmissions, plus general deterioration and damage resulting from environmental conditions plus long term storage. The Center arranged for an operational testing program at Fort Irwin, California, where many different types of terrain exist, and most operational conditions could be either directly encountered or simulated. The Commandant authorized the exhaustive testing of two prototype vehicles to determine the components most likely to fail, so that these items could receive special attention during the rehabilitation phase. The spare parts problem was attacked through the cannibalization procedure. Headquarters, Marine Corps, was requested to grant cannibalization authority for those items which were not commercially procurable because the OTTER had not been produced for so long and the urgency of the FMFPAC requirements did not permit procurement of most long lead time items. Authority to cannibalize for spare parts was granted in September 1965.

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39 U.S. Marine Corps, Command Chronology, Marine Corps Supply Center, Barstow, California, June 1966.
40 Ibid.
41 U.S. Marine Corps Budget, Industrial Fund Operating Budget, Fiscal Years 1969-1971, 14 October 1969.
42 U.S. Marine Corps, Memorandum, subject: Maintenance Workload and Personnel Data, 14 January 1970.
43 U.S. Marine Corps, Command Chronologies, Marine Corps Supply Centers, Albany and Barstow 1965-1966.

TABLE 35

MARINE CORPS INDUSTRIAL FUND
STATEMENT OF REVENUE AND COSTS
(MARINE CORPS SUPPLY CENTERS)

	FISCAL YEARS		
	1969 Actual ($)	1970 Estimate ($000)	1971 Estimate ($000)
REVENUE			
Manufacture and Assembly	905,790	1,877	530
Construction and Conversion			
Overhaul, Repair, and Renovation	19,858,384	16,799	20,641
Alteration and Modification	26,054		
Research and Development			
Quality Evaluation	871		
Rec., Stowage & Issue of Ammo.			
Support of Service-Wide Supply	3,571,214	4,377	4,100
Support of Tenants and Satellites			
Additions and Improvements to Plant			
Support of Reserve Industrial Capacity			
Other Products and Services	101,319	185	185
Total Earned Revenue	24,463,632	23,238	25,456
COSTS			
Costs Incurred	24,759,781	25,249	25,614
Materials, supplies, & parts used	9,275,897	9,355	9,477
Salaries and wages	13,170,114	13,659	13,837
Contractual services			
Other costs	2,313,770	2,235	2,300
Less Costs of Items Manufactured for Activity Inventory			
Costs Incurred for Customers	24,759,781	25,249	25,614
(Increase) Decrease—Work in Process	(134,856)	(2,011)	(158)
Cost of Goods and Services Produced	24,624,925	23,238	25,456
OPERATING RESULTS			
Net Operating Results	(161,293)		
Prior Year Adjustments			
Adjusted Operating Results	(161,293)		
Operating Results Beginning of Year		(161)	(161)
Accumulated Operating Results	(161,293)	(161)	(161)
OPERATING STATISTICS			
Unfunded Costs	3,817,861	4,305	4,305
Military Personnel	2,963,789	3,451	3,451
Depreciation on Plant & Equipment	854,072	854	854
Other			
Personnel on Board End of Period	2,098	2,224	2,224
Military	470	605	605
Civilian	1,628	1,619	1,619
Operating Costs per Direct Labor Man-Day (Funded)	130.44	129.73	132.27
Direct materials and parts used	44.58	43.54	44.32
Direct labor and overhead	85.86	86.19	87.95
Percent Utilization of Plant	73%	76%	76%

TABLE 36

CONTINENTAL UNITED STATES DEPOT MAINTENANCE
(Dollars in Thousands)

Fiscal Year	Organic	Commercial	Interservice	Total
1965	14,142	914	--	15,056
1966	22,275	1,586	--	23,861
1967	25,384	8,676	--	34,060
1968	22,424	4,347	284	27,055
1969	21,752	8,736	1,834	32,322

4. The OTTERs were completed on schedule, and by 28 September 1965 the last of the 33 vehicles had left the supply center for the port of embarkation accompanied by the spare parts required for the 60-day operational support requirement. On 22 April 1966, CMC directed MCSC, Albany, to send a team to Letterkenny Army Depot, Chambersburg, Pennsylvania, to examine 85 1-1/2 ton amphibious cargo carriers (OTTERs) and determine if 30 of them could be prepared for immediate shipment to WESTPAC. Additionally, this team was to determine how many vehicles could be economically rebuilt at MSC Albany, and, if a 120-day layette of repair parts could be achieved. The total requirement was for a 120-day parts layette for 30 vehicles and a 420-day parts package for 60 vehicles. As the program developed it became apparent that parts would come from many sources, including cannibalization. Accordingly, in response to the need for a centralized point for cannibalizing and consolidating parts, Headquarters, Marine Corps, assigned this responsibility to the Marine Corps Supply Center, Albany. The M-76 OTTER project is an example of coordinated effort.

(b) Rough Terrain Forklifts[44]

1. Certain vital parts for the 6,000-pound rough terrain forklifts did not hold up under RVN use. These were:

Item	Federal Stock Number
Brake Linings	2530 807 4143
Piston	2530 792 8308
Starter	2920 785 0833
Performed Packing	5330 196 5323

2. A critical shortage of stock coupled with long procurement lead times required many actions in order to improve supply support, including: fabrications - 400 brake linings and 500 pistons; use of commonality of parts from similar end items; cannibalization; conversion of aviation brake linings; local procurement; interservice support; field tested fabrications; and use of salvage parts for repair or rebuild. The center explored the possibility of using Australian fork-lift repair parts. Consequently, urgent requirements were met for the four items.

[44] U.S. Marine Corps, Command Chronology, Marine Corps Supply Center, Barstow, 1969.

(c) M-64 EIMCO Tractor Engine[45]

1. In February 1969, the Force Logistic Command in RVN reported that the EIMCO Tractor Engine, M-64, a secondary depot reparable item, had become critical to the degree that intensified management action was required. As a result of engine failures, the deadline of the tractor itself had risen to a high of 57 percent in October 1968 and stayed above 45 percent for the balance of the year. The planned repair activity selected for this item was the 3d FSR on Okinawa. However, the nonavailability of spare parts and inability to execute a commercial contract or interservice support agreement (ISSA) required a revision of the maintenance support plan resulting in the urgent evacuation of the engine to a CONUS depot maintenance activity. A quantity of about 70 engines was involved. While the same inhibitors, i.e., lack of spare parts and contract/ISSA support still remained, the organic depot provided the means to initiate an engineering design change together with in-house fabrication to overcome the deficiencies.

2. The program, although an unscheduled workload, was accomplished on time through an aggressive plan developed by the depot maintenance activity. The manner in which an urgent requirement was met and the ability to overcome numerous problems in order to be responsive to the needs of deployed forces emphasized the importance of an organic depot capability under service control.

(12) The Marine Corps Supply Activity established controls to improve SE Asia support by a special projects office which received all SE Asia requirements reported as critical by the Force Commander. These critical items were handled by manual input to the inventory files. A detailed review was conducted to ensure that all possible supply action was taken including but not limited to substitution, high priority procurement, expediting due-ins, fabrication, assembly/disassembly and cannibalization. After rectifying the immediate supply problems created by the criticality and concentrating on back orders, management pursued actions to negate recurrence of these same shortages. All items under this program were included in a selective buying process whereby monies for direct delivery and stock buys were obligated first. This ensured that dollars were applied initially to the most critical items. A manual capability was set up for back order techniques and reconciliation so that the item manager could manually induct transactions to release selective back orders or to effect quantity challenges with the requisitioner in the event that suspect quantities were requisitioned.[46]

e. Secondary Depot Reparable Program. Although the Secondary Depot Reparable Items Program was established in 1965, it underwent a major overhaul and reorganization in 1967. As a result of the buildup of the Marine Corps for Vietnam, it was not until late 1967 that a formalized secondary depot reparable item program came into being that would satisfy the increased requirements. The authorization of an additional Marine Corps division and increased requirements as a result of combat usage, created an imbalance between secondary depot reparable inventory levels and requirements. The limited inventory coupled with the collateral problem of obtaining sufficient shipping prevented the repair program from developing to the extent necessary to meet existing requirements.[47] A continued sizable investment in secondary reparable items to augment the existing inventory was made in an effort to build up maintenance floats to enhance the ability of using units to retrograde components and build up the secondary depot reparable item program to the level it is today. The procurement investment with procurement Marine Corps (PMC) funds is shown in Table 37 with the associated increase in operations and maintenance (O&M) expenditures to support the total repair program.[48]

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[45] U.S. Marine Corps, Command Chronology, Marine Corps Supply Center, Barstow, 1969.
[46] U.S. Marine Corps Briefing, subject: Supply Management, Marine Corps Supply Activity, Philadelphia, 15 September 1969.
[47] U.S. Marine Corps, Memorandum, subject: Service Supply Management, 10 October 1969.
[48] Ibid.

TABLE 37

SECONDARY DEPOT REPARABLE ITEM PROGRAM
ACTUAL AND PROGRAMMED EXPENDITURES ($)

Fiscal Year	Operations/Maintenance (For Repair)	Procurement, Marine Corps
1966	250,000	6,304,008
1967	370,000	23,433,747
1968	1,166,000	33,593,652
1969	2,329,000	31,014,540
1970*	5,700,000	24,958,000

*Programmed for FY 70.

f. Materiel Readiness

(1) A close follow-on to the implementation of the Marine Corps Automated Readiness Evaluation System (MARES) (paragraph 3e(2)), a Logistic Readiness Center was established in Headquarters, U.S. Marine Corps. The main purpose of the Logistic Readiness Center is to develop and operate the MARES logistic reporting system. Further, the Assistant Chief of Staff G-4 uses the center in closely monitoring the materiel readiness of the Marine Corps. It will have a greater importance as a more refined system is developed in connection with the Marine Corps Integrated Maintenance Management System.[49]

(2) Figure 29 depicts data displayed for analysis and action based on the combined deadline rate for all commodities (except Navy furnished) within specific commands as of 15 October 1969. The Marine Corps is placing more and more emphasis on equipment readiness data as a management tool in measuring the effectiveness of its maintenance programs.

3. CHANGES, PROBLEMS, AND CORRECTIVE ACTION IN MAINTENANCE SUPPORT DURING THE VIETNAM ERA

a. General. As the effects of climate and sustained usage amplified maintenance requirements and as forces steadily grew, the initial concept was altered to shift the maintenance effort closer to the combat user. Increased fourth echelon maintenance and responsibilities were assigned to the Force Logistics Command and its subordinate Force Logistic Support Groups.

b. Organization[50]

(1) The solutions to the logistic challenges of Vietnam included tailoring of a new Marine logistic structure in-country; it was adapted to the prolonged commitment to land operations yet retained an ability to be reconstructed into an amphibious posture.

(2) The 3d Force Service Regiment (FSR) was located on Okinawa at the start of 1965 under operational control of the commanding general (CG), 3d Marine Division. It was intended to provide mobile combat service support to the 3d Marine Division, 1st Marine Aircraft Wing, and attached Fleet Marine Force units employed separately or as a Marine Expeditionary Force. In this capacity it was designed to back up the service battalion of the division and the Marine Wing Service Group (later called Support Group) of the Aircraft Wing. What actually occurred under the circumstances of the Vietnam conflict was the incremental deployment of a portion of the 3d FSR to III MAF; reorganization of the residual FSR on Okinawa on a provisional

49 U.S. Marine Corps, Memorandum, subject: Marine Corps Maintenance Management Objectives, 19 December 1969.

50 U.S. Marine Corps, Fleet Marine Force Pacific, Southeast Asia Operations, 1965-1969.

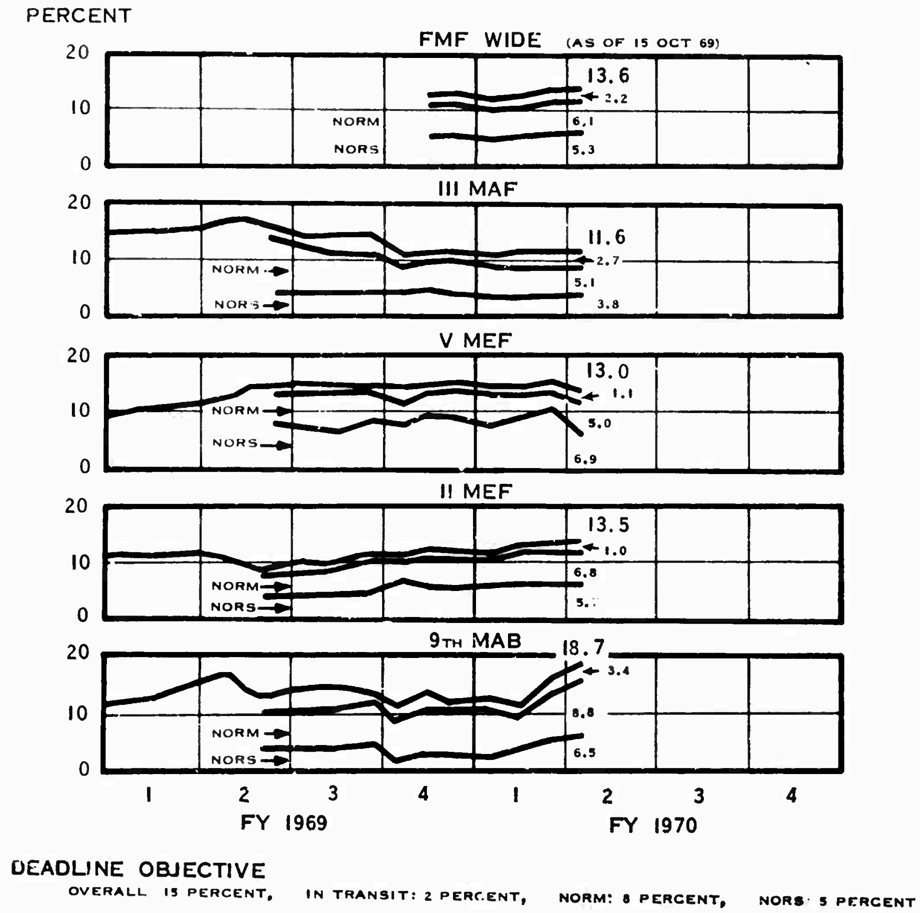

FIGURE 29. COMBAT ESSENTIAL EQUIPMENT DEADLINE FOR SELECTED MAJOR COMMANDS (EXCEPT NAVY-FURNISHED)

basis; and use of it by CG, FMFPAC, to support Marine Corps forces throughout WESTPAC, as well as to provide critical support to III MAF, particularly in the areas of maintenance, supply control, and fiscal matters.

(3) On 28 June 1965, a logistic support group consisting of 22 officers and 432 enlisted from the 3d Force Service Regiment, 1st Force Service Regiment, and 1st Service Battalion departed Okinawa for Vietnam. This unit carried the entire maintenance float of the 3d Force Service Regiment with considerable quantities of its T/O and garrison equipment. Personnel, the maintenance float, maintenance shop equipment and organic vehicles of this group were split up and sent to augment the Force Logistic Support Group at Da Nang and the Force Logistic Support Units at Chu Lai and Phu Bai. This was the first sizeable augmentation to Marine Corps logistic forces in Vietnam. Considerable talent in both supply and maintenance was included in this augmentation and significant improvement within the stock account, warehousing, and maintenance areas at the three combat bases then became possible, and, in fact, was realized.

(4) The eventual logistic organization of III MAF resulted from the incremental deployment of Fleet Marine Force, Pacific, and ground and aviation logistic support assets from Okinawa and Japan, augmented by deployments in FMFPAC personnel from California bases. In March 1966, they were integrated into the Force Logistic Command. These logistic support units, capable of amphibious operations, were combined into a control structure uniquely created

for the situation in Vietnam. Evolution of the basic structure was not completed until February 1967. At this time the strength of the FLC was 5,500 personnel. The FLC task organization employed the assets of one full strength force service regiment, two Marine Corps division service battalions, one force separate bulk fuel company and an augmentation of approximately 300 billets. In essence, the service battalions of the two Marine Corps divisions became the logistic support groups and the organization of the 1st FSR provided the framework for the headquarters and the heavy logistic activities of the FLC. By adapting existing T/Os to the particular requirement in I Corps Tactical Zone (I CTZ), the Marine Corps sought to retain a flexibility for later reconstituting all, or a portion of, the original organizations and preserved the essential amphibious character of the Marine Corps forces deployed.

(5) Logistic forces in-country were not standard T/O units, as they were formed incrementally and task organized. As a result, these organizations were staffed by personnel who had not trained together as a unit during peacetime which caused delays in writing operating procedures thus creating voids in records and publications.

(6) The buildup of logistic forces and facilities in Vietnam and on Okinawa did not keep pace with the buildup of combat forces. This was caused in part by the shortages of personnel in depth and in talent within the 3d Force Service Regiment and the 3d Service Battalion prior to the advent of hostilities and by command decisions as to the priority of assignment of personnel.

c. System Changes

(1) General

(a) The Marine Corps Unified Materiel Management System (MUMMS) was declared partially operational 1 May 1967 and was designed to include the standardized requirements of the Department of Defense Military Standard Requisitioning and Issue Procedures (MILSTRIP), and Military Standard Transaction Reporting and Accounting Procedures (MILSTRAP). The concepts of the Military Supply and Transportation and Evaluation Procedures (MILSTEP), Military Standard Transportation and Movement Procedures (MILSTAMP), Military Standard Contract Administration Procedures (MILSCAP), and the Defense Supply Agency Mechanization of Warehousing and Shipment Processing (MOWASP) are included in the system design (see Figure 30).

(b) Depot Maintenance Management Systems (DMMS)[51] is a subsystem of the Marine Corps Unified Materiel Management System (MUMMS). It automates portions of maintenance management at the two Marine Corps depot maintenance activities. The system deals with manpower management, materiel requirements, job scheduling, costing and budget data. The system does not prescribe total local operating procedures, but rather establishes those procedures which are essential to ensure that management at the depot level will meet the operating and productivity standards required for this element of the overall Marine Corps equipment maintenance program.

(2) HAWK System Equipment Maintenance Case Analysis[52]

(a) General. The maintenance plan for the HAWK System, which was established upon introduction of the system into the Marine Corps, was in consonance with the basic principles of Marine Corps maintenance doctrine. Basically the doctrine provides that maintenance operations be assigned to specific levels of command consistent with the primary mission, character, and mobility of the command involved. It also provides for performance of repairs at the lowest echelon of maintenance at which parts, tools, support equipment, and requisite skills exist. First through fourth echelons of maintenance were assigned to the Light AntiAircraft Missile Battalions (LAAM) and repair parts for LAAM equipment were coded

[51] U.S. Marine Corps, Depot Maintenance Management Manual (MCO P4400.81), 8 January 1967.
[52] U.S. Marine Corps, Memorandum, subject: Equipment Maintenance, 9 December 1969.

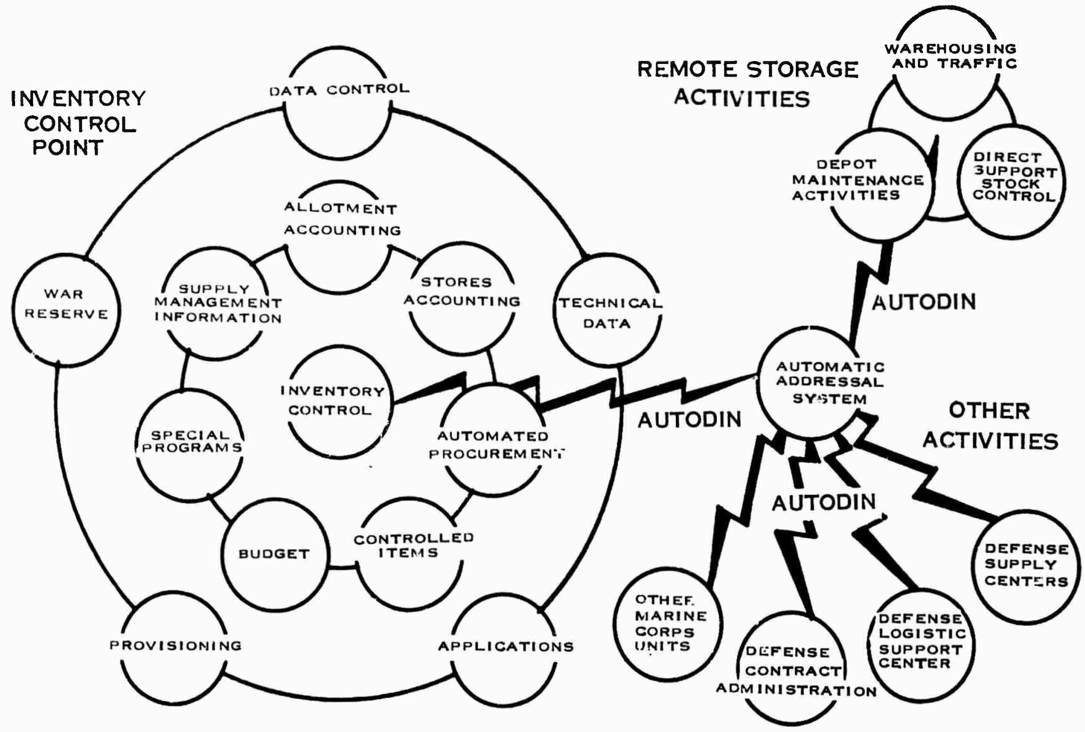

FIGURE 30. MARINE CORPS UNIFIED MATERIEL
MANAGEMENT SYSTEM INTERRELATIONSHIPS

accordingly. Spare parts authorized the LAAM Battalions consisted of special plug-in chassis, subassemblies and components which were listed in Marine Corps Stock List SL-4-02626A. Stockage of bit parts and pieces were authorized using organizations in quantities determined by usage data.

(b) Maintenance Problems Encountered. Shortly after deployment of LAAM units to RVN, it became apparent that the usage data developed during peacetime were not adequate to support the system for full time usage in a combat environment. Seventy percent of HAWK equipment failures were of the category termed random because the usage data provided by the failure were too low to authorize parts stockage at the battalion level. Equipment readiness status rapidly deteriorated due to the lack of parts availability and the long lead time for parts procurements.

(c) Management Action. Analysis of the factors involved in the maintenance of HAWK system equipment revealed the following factors relating to the level of maintenance.

1. The LAAM Battalion possessed the requisite skills and test equipment to perform the required maintenance (1st through 4th echelon).

2. Long lead time required upon requisitioning parts for the majority of repairs was the major contributing factor to excessive downtime for repair. As a solution to the problem, the concept of the Essential Stock List (ESL) was developed. The stockage authority granted by the ESL allowed an increased range and depth of parts, not necessarily based on usage data. The objective was to shorten equipment down time by timely repair of equipment failures in low density parts and components by maintaining repair parts for support of such items on-hand. The increased quantity and variety of repair parts made available to the LAAM Battalions allowed greater use of the technical skills of available maintenance personnel and eliminated a significant number of excessive lead time problems. The concept was promulgated in MCO 4408.3 of 12 July 1967 thus providing information on the ESL. Initially, due to funding

limitations, only RVN deployed HAWK units were authorized use of the ESL. Force feeding of parts was employed in the implementation of the ESL concept.

(d) Impact. The urgent operational requirements of RVN deployed units dictated immediate implementation of the ESL. An exception was therefore made to established supply support concepts, wherein stores stocks were used to fill the ESL instead of effecting procurement of the necessary parts prior to implementation of the ESL.

1. The impact on deployed units was a significant increase in equipment readiness. The high drawdown of stores parts, which depleted Marine Corps stocks on a large number of items, caused an increased deadline rate of HAWK equipment in CONUS units. The shortage of certain parts in the supply system existed for up to one year before complete restockage of stores system assets was accomplished.

2. The initial step of incorporating the ESL into the maintenance plan of the HAWK system has had further impact on the total logistic system. The ESL concept has been applied in the support planning for other complex electronic systems of low density. The ESL has evolved into the Minimum Stockage List (MSL). Various critical low density electronics systems have been identified in MCO 4400.116 and MSLs authorized for those units (including LAAM Battalions) possessing the critical low density equipment.

d. Distribution of Workload

(1) Depot Overseas[53]

(a) The deployment during 1965 and the first half of 1966 of increasing numbers of Marine Corps ground and aviation units to South Vietnam, together with the rapid accumulation of equipment usage and maintenance data in-country, demonstrated a need to reduce the amount of equipment-use time lost by the evacuation of selected major items of equipment to the United States for repair and rebuild, and their subsequent return to the using units. The effort to reduce this time loss, by displacing a 5th echelon capability westward from CONUS to 3d FSR, and a fourth echelon capability subsequently in South Vietnam, improved the maintenance effort somewhat, but not to the desired degree.

(b) In July 1966, therefore, the WESTPAC Repair/Rebuild Program was initiated by Fleet Marine Force, Pacific. As initially conceived, the program's first mission was to bridge the electrical generator repair/rebuild capability gap then existing between the in-country Force Logistic Command, the Okinawa-based 3d Force Service Regiment and Marine Corps repair depots in the United States. The program was soon broadened to include other items essential to III MAF's combat operations.

(2) Contractual Support.[54] In-country, commercial contractual support of in-country operations in SE Asia in 1965 amounted to $185,000 and by 1967 had increased to $317,000. In RVN the Force Logistics Command utilized the Interservice Supply Support Agreement (ISSA) with the Army and the Air Force; and intraservice, with the Navy. Offshore, the 3d Force Service Regiment utilized the 2d Logistical Command, Okinawa, and Public Works Center, Yokosuka.

(3) Maintenance Balance Program.[55] The Commanding General, Fleet Marine Force, Pacific (CG, FMFPAC), recognized that increased force levels and the quickened pace of combat operations in-country would require augmentation of the repair/rebuild capabilities of the aforementioned Marine Corps agencies. Consequently, interservice support agreements and contracts with civilian Japanese and Ryukyuan concerns were quickly negotiated. Further, in order to take maximum advantage of the capacities and superior facilities of the various out-of-country repair agencies, as well as to achieve a balanced maintenance effort between in-country

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[53] U.S. Marine Corps, Fleet Marine Force, Pacific, Southeast Asia Operations 1965-1969.
[54] Ibid.
[55] Ibid.

and out-of-country efforts, the Force Logistic Command was instructed to evacuate to out-of-country agencies those items requiring more than 60 days to repair, or for which repair parts were not readily available. Additionally, the 3d FSR echelon repair/rebuild effort was limited to selected motor transport and artillery items. The Maintenance Balance Program from January 1968 through August 1969 covered 2,950 major end items from RVN: 1,200 being repaired and returned to user, 1,580 requiring replacement, and, 170 in process of repair for return.

(4) Activation of 5th Marine Division (1 March 1966).[56] The impact of the 5th Marine Division Activation on the CONUS depot maintenance effort was manifested in two areas or programs: the Preparation for Shipment Program and the 4th Division/Wing Team Ready Line Project. The Preparation for Shipment Program was considerably increased to issue items to the 5th Division. Increasing man-hours in this program necessarily reduced man-hours available to the repair program. The activation of the 5th Marine Division did have considerable impact on the Depot Maintenance Activities' 4th Division/Wing Team Ready Line Project. A considerable number of the items which had been processed under this project were used for initial outfitting of the 5th Marine Division. In reconstituting the 4th Division/Wing Team Ready Line the parameters of the 4th Division/Wing Team Ready Line Project were increased to include repair/rebuild of certain designated items which were placed in the Annual 5th Echelon Program.

(5) Deferred Maintenance[57]

(a) Deferred maintenance did not have any particular impact on major end items relating to the responsiveness to the Southeast Asia buildup. The present scope of deferred maintenance within the Marine Corps totals approximately 12.9 million dollars which includes ordnance, motor transport and communication electronics type items. This deferral is considered as a programmed deferral and reflects maintenance at the depot level only as data at any other level of maintenance is unavailable.

(b) Presently the backlog of deferred depot level maintenance is considered yearly as part of the new fiscal year maintenance requirement. When financial constraints are imposed then decisions are made as to what should be repaired based upon an item-by-item need. The Marine Automated Readiness Evaluation System (MARES) reporting system provides data for highlighting problem areas which in turn influence the decision made on deferral maintenance.

e. Expediting and Control Systems[58]

(1) RED BALL. In September 1965, in an effort to provide special response to urgent supply requirements affecting mission capability, the RED BALL system was initiated. Once an item was declared RED BALL, a daily monitoring of its status was required by every element of the supply system in FMFPAC. The only satisfactory condition for removing an item from RED BALL was the receipt of the needed item (or a suitable substitute) by the user. Only items of combat essential equipment qualified for RED BALL treatment. Once an item was nominated for RED BALL, agencies within the supply channel had 24 hours in which to forward the item by air, if it were air transportable, or to forward a RED BALL priority dispatch to the next higher echelon within the supply channel. Initially, many items qualified for RED BALL designation, and the list grew steadily. However, the decline in the number of items on RED BALL by April 1967 made it clear that the FMFPAC logistics complex was more responsive. In October 1967 the RED BALL system was cancelled. From August 1968, the Marine Corps Automated Readiness Evaluation System was the means for reporting and monitoring of items requiring intensified action.

(2) The Marine Corps Automated Readiness Evaluation System enables Marine commanders to evaluate current and projected capabilities of Fleet Marine Forces to execute

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[56] U.S. Marine Corps, Memorandum (JLRB-FLF-rcr), subject: Maintenance Workload and Personnel Data, 14 January 1970.

[57] U.S. Marine Corps, Memorandum, subject: Deferred Maintenance, 15 October 1969.

[58] U.S. Marine Corps, Fleet Marine Force, Pacific, Southeast Asia Operations 1965-1969.

contingency and other plans, through the analysis of personnel, training, logistics, combat readiness, and combat status reports produced within the system. Upon termination of RED BALL there were 873 requisitions outstanding; these continued expeditious processing under RED BALL procedures until the material was received. Critical requirements from then on were submitted from the field in accordance with the provisions of MARES. Benefits gained by the change were:

(a) More rapid response through automated processing.

(b) Greater capability of alleviating shortages by management at the Headquarters, Marine Corps level, where redistribution can be effected from Marine Corps-wide assets.

(c) Elimination of the duplication of effort created by multiple expediting systems operating at different management echelons.

(3) CRITIPAC. The Critical Package (CRITIPAC) Program was established by Fleet Marine Force Pacific for the purpose of shipping materiel directly to the user to meet operational requirements and bypassing intermediate support elements, both offshore and in-country. Requisitions were immediately processed for assets Marine Corps wide and a predetermined date for total shipment established. The shipment was made in unitized crates, each not to exceed 400 pounds, by air unless overall shipment exceeded aircraft availability. The CRITIPAC concept worked extremely well as a quick reaction capability. In July 1966, the improved support for Vietnam together with the improved position of the 3d FSR permitted discontinuation of this expediting program.

(4) PROJECT DEP REP[59]

(a) In March 1967, the Marine Corps recognized the need to reemphasize the importance of expeditious movement of reparable items between maintenance echelons, especially items being returned to supply centers from overseas units, in order to have an effective secondary reparable item program. It activated a test for the movement of retrograde secondary depot reparables with the title of Project DEP REP. The test objective was to measure the extent of elapsed time in shipment from originating unit to the supply center, evaluate the quantities and types of secondary reparables being evacuated, and emphasize return of only those items that were economically reparable assets. The test covered the period from 15 April 1967 to 14 April 1968.

(b) Assistant Secretary of Defense (Installations and Logistics, Comptroller) by joint memo of 20 October 1966 advised that only about one-third of the capacity of aircraft of the Military Airlift Command (MAC) returning from the Pacific area was utilized effectively—despite the urgent requirement to speed up the return of reparable items to overhaul and serviceable items to the control of inventory managers for redistribution. Therefore, in order to optimize the use of available airlift resources, and to measure the extent to which such use could contribute to improved supply effectiveness, a test program, Project HIGH FLY, was established for retrograde air movement of items at reduced costs. Secondary depot reparable items, as a result of implementing instructions of "Project HIGH FLY," did not meet criteria necessary for inclusion in this test. Realizing that valuable test information could be obtained, "Project DEP REP," a Marine Corps project, was established to evaluate the retrograde movement of these items. This project, established by CMC letter CSR-8-bf, 4400 over 12, of 20 March 1969, was intended to measure the time required for retrograde shipments of secondary depot reparables. It also was to provide information on the numbers and types of depot reparable components being returned, and their impact on resupply and procurement programs.

(c) During the course of the test period from 15 April 1967 to 15 April 1968, 538 line items were screened representing approximately 4,000 units.

[59] U.S. Marine Corps, Memorandum, subject: Project DEP REP, 19 December 1969.

(d) An analysis of reported figures on Project DEP REP provided a basis for management decisions in the Marine Corps Secondary Reparable Item Program. It was determined, as an example, that of the item issues screened where unserviceables were not evacuated, approximately 82 percent resulted from washouts at the 4th echelon, or from issue for initial allowance requirements, thereby constituting nonrecurring demands with no evacuation of an unserviceable component required. As a result, procedures governing the operation of the Secondary Reparable Item Program were changed, or strengthened, to provide a more stringent review of authorized float allowances prior to issue of serviceables when the requisition indicated no associated unserviceable returns. Further, procedures were changed to reduce washout at the 4th echelon, without prior review of the ICP, in order to capture any possible assets required for system use. Transit times generated were for the most part adequate but did not provide sufficient data for the establishment of a valid average retrograde time. In that the test identified problem areas as described, and stimulated retrograde movement of secondary depot reparables, it was worthwhile.

f. Maintenance Assistance Teams. Maintenance Assistance Teams were instrumental in maintaining equipment readiness. There were two types used.

(1) Technical Assistance Teams for each commodity area conducted on-site analyses of maintenance problems and usage of equipments. These analyses were evaluated against capabilities and decisions were made that ultimately increased availability of equipment.

(2) Contact Instruction Teams composed of experienced personnel in their maintenance specialty conducted on-the-spot instruction in the applicable level of maintenance. These teams stressed operator and organizational maintenance, compliance with instructions, record keeping, and safety.

4. STRENGTHS, WEAKNESSES, AND LESSONS LEARNED

a. The Marine Corps logistic structure, including the maintenance function, operated through a series of in-being organizations from the continental United States and extending overseas to the lowest unit authorized to perform maintenance. These organizations, manned at all echelons with military personnel and operating the same in peacetime and wartime, permitted the transition into combat with no substantive change in concept, policy, or procedure.

b. The ability to structure maintenance elements of combat service units accommodated the maintenance requirements of a variety of tactical task organizations and still maintained the required level of equipment readiness.

c. The pre-positioning of war reserve stocks at or near the point of planned use or issue to the user to ensure timely support of designated forces during the initial phase of RVN was responsible for the initial success of maintenance support.

d. The distribution of the maintenance workload within the Marine Corps is effective in attaining the desired degree of equipment readiness.

e. The Marine Corps Automated Readiness Evaluation System improved reporting, visibility, and follow-up on deadlined equipment.

f. The maintenance difficulties encountered by the Fleet Marine Force were directly related to deficiencies in either repair parts or assets for repair.

g. The most serious deficiency appeared in the secondary depot reparable program. Designed to ensure a predictable flow of reparables from deployed units to the Marine Corps Supply Centers for rebuild, this program lagged well behind predictions due primarily to the natural reluctance of the using units to lose control and ownership of these items. As a result, there was a lack of reparable items at the depot maintenance activities. The situation was then further compounded by erratic scheduling for repair as well as adjustments to the budget to meet all requirements.

h. The military maintenance billets in the Marine Corps, extending from organizational through depot level maintenance, provided a rotation base for maintenance personnel between overseas and CONUS activities which enhanced individual development of skills attendant to a functional specialty.

i. The importance of the organic depot maintenance was illustrated by its capability to meet expanded programs, including newly activated units. Further, the depot maintenance activities demonstrated ingenuity and technical sophistication in their support of deployed Fleet Marine Forces.

j. The financial limitations annually placed on the Marine Corps makes it difficult to maintain a balanced civilian personnel work force at the depot level. It is important to have a prescribed workload which not only attains the necessary equipment readiness but also the means to retain skilled technicians who are required to meet this goal.

k. The Marine Corps application of an across-the-board management technique was modified for certain low density commodities that proved effective, leading to the development and use of an Essential Stock List of repair/spare parts, a concept which has been applied to support planning for similar type equipment with a view toward reducing downtime and better use of skilled maintenance personnel.

l. Although there was close adherence to its basic logistics concepts and policies, intensified central management was required through reporting systems, (performance measurement and problem identification) and close coordination of supply-maintenance-financial elements to maximize the availability of equipment. This effort must continue toward further qualitative and quantitative control of assets even in face of the proven support rendered by the logistic system as indicated by the high state of equipment readiness.

m. The Marine Corps processes for the management of elements of its logistics system (supply, maintenance, and finance) were developed into an integrated procedure, aligned to equipment readiness reporting which significantly contributed to the attainment of an overall high degree of equipment readiness.

n. Technical assistance teams again proved to be an effective and efficient means of utilizing skills and increasing equipment availability.

o. In order to maintain maintenance system effectiveness it was necessary to establish special expediting and control procedures for supply, and expand the capabilities for maintenance in designated organizations to degrees or higher echelons which they were not originally authorized.

5. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) The Marine Corps maintenance system, manned at all echelons with military personnel and operating the same in wartime as in peacetime permitted the transition from peace to war with no substantial changes (paragraphs 1a(2), 1c(5), 2a(1)-(4), 2b, and 2c).

(2) The Marine Corps maintenance system permitted the rapid and effective structuring of maintenance support units tailored to meet the equipment readiness requirements of supported combat units (paragraphs 1a(1)-(4), 1b(1) and (4), 1c(4), 2a(1) and (4), 2b, 2c, 2d(2)-(3) and (9), 2f, 3b, 3d, 3g, and 3i).

(3) Equipment readiness reporting was a dominant force in the overall equipment management picture. From August 1968 the Marine Corps Automated Readiness Evaluation System (MARES) provided automated reporting and improved visibility, problem identification and follow-up action on deadlined equipment (paragraphs 2a(3), 2b, 2c(2), 2d(g), 2f, 3c, 3d(6), and 3e).

(4) Central management at Headquarters, Marine Corps, of the major elements of the total logistic system (supply-maintenance-fiscal) was aligned to equipment readiness reporting (paragraphs 1a(7), 1c(2), 1c(5), 1e, 2b, 2d(10), 2f, 3c, and 3e(4).

(5) Effective distribution of the maintenance workload contributed significantly to the attainment of a continuing high (over 90 percent) degree of equipment readiness (paragraphs 1b(2), 1c(3), 1d, 2b, 2d, and 3d).

(6) Technical assistance teams from both depot and intermediate levels proved to be an effective and efficient means of utilizing skills and increasing equipment availability (paragraphs 2b, 2c(9), 2d(9), and 3f).

(7) Organic maintenance was performed in CONUS and overseas by an experienced and balanced military and civilian work force (paragraphs 1a(2), 1c(5), 2b, 2c(4), 2d(6) and (9), and 3d(1) and (4)).

(8) The pre-positioning of war reserve stocks at or near the point of probable use was a sound concept for support of the maintenance effort (paragraphs 1a(1), 1b(3)-(4), and 2b).

(9) The existence of a rotation base for Marine Corps maintenance personnel enhanced personnel skill development and diluted the effects of personnel turbulence in the combat zone (paragraphs 1c(5), 2d(2) and (4), and 3d(1)).

(10) Positive management of depot reparables (major and secondary items) was essential to the prosecution of an effective Marine Corps maintenance program (paragraphs 1c(5), 1e, 2a(5), 2b, 2c(4), 2d(10), 2e, 3d(3)-(4), and 3e).

b. Recommendations. Recommendations pertaining to the Marine Corps are given in Chapters VII, VIII, IX, and XII.

CHAPTER VI

AIR FORCE MAINTENANCE

1. GENERAL

a. Concept

(1) In building the nuclear strategic force in the 1950's, the Air Force subscribed to readiness before the fact rather than mobilization after the fact. The logistic system was tailored accordingly. The short duration all-out effort envisioned during the 1950's supported the concept that each operating base should achieve the maximum degree of self-sufficiency. Such independence would ensure a maximum effort should the forces become engaged. Overseas depots were phased out and logistic support was tailored around fast communications and airlift directly to and from CONUS depots. It was envisioned that nonnuclear conflicts would involve relatively small forces for comparatively short periods. The logistic support for such tactical forces was designed around mobility concepts of rapid deployment to any part of the world with initial 30-day spares support provided from mobility kits. The basic concept of waging war with forces in-being and maximizing the independence of operating forces placed the Air Force in good stead at the initiation of the Vietnam conflict and throughout the Vietnam era.

(2) The Air Force concept for support is to employ direct electrical communications between the user (base) and the responsible source of supply, Air Materiel Areas (AMAs), for needed items. There is no intermediate supply depot or headquarters through which such communications are channeled. The responsible AMA must satisfy the needs within the required time frames. The use of airlift for high priority and high cost items is basic to this concept.

(3) The success of the Air Force logistic system depends on the integration of the separate functions of supply, transportation, and maintenance. The maintenance concept establishes the repair cycle and the quantity, range, and location of spares and repair parts that must be provided by supply. The reliability of equipment determines the failure rate and the time to repair an item establishes the repair cycle time. Assets are procured to support repair cycle times. Items that cannot be restored to a serviceable condition at the intermediate level are shipped to the appropriate depot repair facility.

(4) A logistic air system links all Air Force depots, bases, and aerial ports of embarkation. The system is operated by commercial carriers under contract to the Air Force. The regular schedules can be changed on short notice to provide point-to-point movement. Air movements to overseas theaters are handled by the Military Airlift Command.

(5) The integration of the subfunctions of logistics in the Air Force has been responsive to operational requirements during the Vietnam era. In calendar year 1969 the average time to receive a Not Operationally Ready—Supply (NORS) item by the Thirteenth Air Force (Philippines) and Seventh Air Force (Vietnam) was approximately 5 days.[1]

(6) Weapon systems are designed to support operational concepts, which strongly influences maintenance policies and the design and use of support equipment and maintenance facilities. During development of future aircraft, consideration will be given to designing equipment to permit accomplishment of organizational and intermediate maintenance as distinct

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[1]Headquarters, Thirteenth Air Force, Data provided during visit of Joint Logistics Review Board in September 1969; and Headquarters, Seventh Air Force, Letter, subject: Statistical Data Pertaining to NORS G Requirements, 11 November 1969.

entities at different operation locations.[2] This separation of organic from intermediate maintenance will facilitate operation under the forward operating base (FOB)-main operating base (MOB) concept. Once implemented, this policy will increase the feasibility of a further separation of maintaining equipment in CONUS in lieu of in combat environments.

(7) Although mobility has been practiced by the Air Force for years, the experiences of Vietnam have highlighted the need for improvements. The Air Force has reacted to this need by increasing emphasis on mobility planning and design for mobility. Project CORONET BARE demonstrated the features of new equipment and facility designs and how this equipment could be used to transform a bare base into a completely operational main operating base in a relatively short period of time. Recent Air Force publications relating to mobility are:

Air Force Manual 28-43, Mobility for Strategic Forces (U), 15 July 1969 (SECRET).

Air Force Manual 2-40, Operational Concepts and Capability Standards for Mobility, Austere Basing and Support of Tactical Forces (U), 22 September 1967 (CONFIDENTIAL).

Air Force Manual 28-41, Mobility for Aerospace Defense Forces (U), 17 October 1969 (CONFIDENTIAL).

Air Force Manual 28-42, Mobility for Military Airlift Command Forces (U), 29 January 1970 (CONFIDENTIAL).

The United States Air Force Mobility Plan (U), 1 January 1969 (CONFIDENTIAL).

(8) The total value of property of all kinds in use by the Air Force as of 30 June 1968 was $72.8 billion of which plant equipment totalled $2.251 billion. The inventory within the Air Force supply system was $12.042 billion on that date.[3]

(9) Approximately 338,000 military and civilian personnel are involved in Air Force maintenance, about one third of the total Air Force strength.[4] As of December 1969, there were 7,034 officers and 159,054 enlisted personnel designated for primary duty in the electronics and maintenance engineering career areas of missiles, avionics, aircraft, and munitions.[5]

(10) Of the personnel assigned to organizations actively involved in a conflict, a high percentage are maintenance personnel. The 33rd Tactical Fighter Wing, equipped with F-4 aircraft, is representative of the manning of such a unit. Of the 301 officers, 2,320 airmen, and 8 civilians authorized in the wing, 48 officers, 1,991 airmen, and 3 civilians have maintenance as their primary duty. Thus, 78 percent of the total wing strength is directly involved in maintenance.[6] The base supply function and other logistic support for this wing is accomplished by a Combat Support Group not assigned to the wing. Some commands use a higher proportion of civilian personnel as a stabilizing force in intermediate maintenance activities at fixed bases to permit uninterrupted operation of these facilities when military personnel are transferred or deployed.

(11) In the production or repair area the depot maintenance workload was about 114,000 man-years. To accomplish this workload there were some 52,000 civilian employees in the AMAs. This represented 46 percent of the workload accomplished organically. The remaining 54 percent was accomplished on contract. There are about 2,000 engineering personnel

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[2]Headquarters, U.S. Air Force, Mobility Plan (U), 1 January 1969, paragraph 2d, pp. D-2, 3 (CONFIDENTIAL).
[3]U.S. Congress, House of Representatives, Committee on Government Operations, Federal Real and Personal Property Inventory Report (Civilian and Military) of The United States Government Covering Its Properties Located In The United States, In The Territories, and Overseas As of June 30, 1968, 91st Congress, 1st Session.
[4]Headquarters, U.S. Air Force (AFSMEPB), Presentation on The Air Force Maintenance System to the Joint Logistics Review Board, 9 May 1967.
[5]Headquarters, U.S. Air Force, Director of Maintenance, AFSME, Telecon, 17 December 1969.
[6]U.S. Air Force, 33rd Tactical Fighter Wing, Unit Detail Listing (UDL), 31 March 1969, 3rd Quarter, FY 69.

capable of accomplishing about 10 percent of the engineering workload. The remaining 90 percent is contracted out to industry, usually the equipment manufacturer.[7] The Air Force Logistics Command (AFLC) is the Air Force's largest user of civilian personnel. The five AMAs in the AFLC have personnel strength and structures similar to the Oklahoma City Air Materiel Area (OCAMA). Of the total population excluding base functions, only 671 are military, including 178 (108 in maintenance) assigned to the Combat Logistics Support Squadrons. Of the 12,574 personnel assigned to depot maintenance, only 18 are military. The OCAMA work force distribution as of April 1969[8] is given below.

OCAMA Population (Total)	22,539
Maintenance	12,574
Materiel Management	3,663
Procurement	628
Comptroller	990
Supply and Transportation	3,958
Other	3,177

(12) The depot maintenance workload requirement is related principally to the size and composition of the force structure, with related support equipment, and the rate at which the force is used. The capability and capacity to perform the required depot maintenance workload, whether by the organic depots of the AFLC or in contractor facilities, are constrained by the size of the Air Force Operations and Maintenance (O&M) budget and/or by manpower ceilings. As a general rule, work excess to the capacity of the AFLC maintenance work force is contracted, if funds are available. Contracting, however, is contingent upon the availability of contractor resources and the technical capability of his work force. When sufficient funds or contract sources are not available, management is faced with balancing that workload which must be accomplished against that which can be deferred. This process is a severe and continuing management problem. The lowest priority requirement is deferred initially, but as the quantity of deferred maintenance increases, it is necessary to defer higher priority requirements.

b. Policies

(1) The basic Air Force maintenance policy is to place the responsibility for maintenance at the lowest level at which work can be accomplished effectively, consistent with skills, equipment, facilities, and other resources. It is also Air Force policy to design the organizational structure of the maintenance function in a manner that guarantees an in-being maintenance capability to support both limited and general war operations. For those items returned to a depot for repair, the Air Force has a single point repair policy that provides, when possible, one specialized repair facility for each item requiring depot level repair. Also, under a collocation policy, this point of repair is at the same AMA where the item is managed, if feasible. This practice results in the consolidation of all resources, responsibility, and authority under one commander to ensure economical repair of items and to provide fast repair cycle times when needed to meet mission requirements.

(2) Maintenance in the Air Force is divided into two general categories: base maintenance and depot maintenance. The scope of maintenance performed at each level is commensurate with personnel, equipment, technical data, and facilities provided. Base level maintenance, encompassing the organizational and intermediate levels, is accomplished while the item remains in the custody of the using command. When the using command does not have the necessary

[7] U.S. Air Force Logistics Command, Brochure, subject: Maintenance Engineering 1968, October 1968, p. 51.
[8] U.S. Air Force, Oklahoma Air Materiel Area Briefing, Brochure, subject: Depot Maintenance/Depot Maintenenace Management Relationships, undated.

repair capability or authority, the item is returned through supply channels to the depot having repair responsibility.

(3) The Air Force develops and/or retains an organic depot level capability for mission-essential materiel that requires continuing depot level maintenance to sustain operations under emergency or wartime conditions, or which requires such depot maintenance in peacetime to assure materiel operational readiness. Contract maintenance is used primarily for accomplishment of nonmission-essential depot maintenance requirements and those mission-essential requirements which exceed existing organic capacity, consistent with economies and effectiveness without compromising the military mission responsibilities. Interservice support is used when economies can be realized and existing capabilities of other Services can be utilized without impairing the military mission. The Air Force has numerous interservice support agreements, especially with the Navy. Examples are: The R3350 engine for the A-1E aircraft, of which 134 are being overhauled for the Air Force by the Navy during FY 70 at Naval Air Station, Alameda; the AIM-7E missile, of which approximately 3,000 are being overhauled by the Navy for the Air Force during FY 70 at both Norfolk and Alameda; and the A-1E aircraft, of which 14 are being given inspection and repair as necessary (IRAN), modifications, and/or crash battle damage repair at the Navy facility at Quonset Point.

c. Organization and Responsibilities

(1) Proper maintenance of assigned equipment is the responsibility of command, but the maintenance function is accomplished under centralized management. At the Headquarters, Air Force, level the Director of Transportation has the staff responsibility for vehicle maintenance while the Director of Maintenance Engineering is the Air Staff member responsible for all other equipment except medical and real property. Both of these offices are subordinate to the Deputy Chief of Staff, Systems and Logistics, and have staff elements capable of administering and monitoring maintenance programs in addition to establishing basic policy guidance for all Air Force maintenance activities within their jurisdiction.

(2) The Air Force Logistics Command provides general directives, instructions, and technical data throughout the Air Force under the policy direction of Headquarters, Air Force. The Deputy Chief of Staff/Maintenance Engineering of Headquarters, Air Force Logistics Command, delegates the necessary authority to the Directors of Materiel Management and the Directors of Maintenance who manage and implement the maintenance programs in the five Air Materiel Areas. The AMAs under policies emanating from Headquarters, Air Force, determine the scope, level, and frequency of maintenance required on their assigned equipment, components and weapon systems. All AMAs possess identical management responsibilities applicable to their support responsibilities.

(3) Although using commands have maintenance staffs at each succeeding level of command, the heart of the maintenance organization is at the base level. Here, there is a standard organization where all maintenance is consolidated under a single Chief of Maintenance. In accordance with this consolidated maintenance concept, the Chief of Maintenance "owns" the basic vehicles (aircraft, missiles, etc.) and all resources necessary to their maintenance support. He is responsible for providing serviceable aircraft or other end items when and as required by the operational element for the performance of the mission. The Chief of Maintenance manages the maintenance organization by the procedures outlined in Air Force Manual 66-1. Functional management responsibilities assigned to the Chief of Maintenance are planning, controlling, executing, and producing. He and his staff provide the direction and guidance essential to ensure that subordinate maintenance activities implement and comply with local and higher authority policies and technical instructions.

d. Maintenance Management

(1) Air Force Manual 66-1 specifies the maintenance management system applicable to organizational, intermediate, and depot level maintenance. Using organizations, or designated maintenance activities supporting the using organizations, perform organizational and intermediate maintenance. Prior to January 1969, the objective was to fully utilize the organizational

and intermediate capabilities and reserve the depot level for only that maintenance beyond base maintenance capabilities. This practice was referred to as the maximum base maintenance self-sufficiency concept. A joint Air Force Logistics Command/Air Force Systems Command panel (Panel 31) was chartered in May 1966 to review the subject of repair level decisions. These studies disclosed that through the application of the base self-sufficiency program and a continuing effort to implement its policy resulted in a reduction of the inherent mobility and flexibility of the tactical forces. The sheer mass of equipment, supplies, and facilities required to sustain a force not only reduced its mobility but created logistic support problems as well. It was determined that both direct and indirect support resource requirements could be reduced and operational effectiveness improved by optimizing the repair level decision at base or depot rather than striving for maximum repair authorizations at base level. In January 1969, the maximum base maintenance self-sufficiency concept was rescinded and an optimum repair concept established.[9] As a result, maximum base repair is no longer the goal in making repair level decisions. However, the policy on maximum base maintenance self-sufficiency was clear and forceful; whereas the new policy on optimum repair is vague and the procedures for determining optimum repair are not prescribed in the current AFR 66-1.

(2) The basis for any sound technical program is the availability and analysis of facts. Among the more comprehensive management programs in the Department of Defense today is the Air Force Maintenance Management System, AFM 66-1. Although the primary objective of this system is for effective management of base maintenance resources, the data produced by this system are the very backbone of the Air Force Logistics Command actions to improve equipment performance and logistic support. The volume of punched cards processed by the AFLC portrays approximately 5,500,000 maintenance actions each month.[10]

(3) Under the AFM 66-1 system, all base maintenance actions accomplished by the mechanic are recorded. For example, when an item is removed from an aircraft the mechanic reports what action was taken, when the condition was discovered, and how it malfunctioned. He further reports the type of maintenance performed, the discrepancy encountered, and whether the part was bent, broken, or corroded. He records if the condition was discovered on the ground, in the air, or during any of several phases of the operation. To evaluate how the condition experienced affects the operation, the mechanic records whether he removed and replaced it, adjusted it, or repaired it in place. He also records the labor hours used, and whether the item could be repaired at the base or the reason it could not be repaired at base level. It is from these basic facts that the Air Force is able to perform technical analysis of the reliability and maintainability of weapon systems and identify areas where modifications are necessary or cost effective.

(4) The Air Force has published tables designed to assist scheduling of weapon systems for depot level modification/maintenance on a calendar cyclic basis.[11] Each year, the system managers of the AFLC and representatives from the using commands review these tables. This review includes analysis of Air Force Manual 66-1 data from both base and depot level activities, findings of analytical condition inspection, and other pertinent data. System Managers use the findings and decisions of the review to substantiate the depot maintenance requirements for the next and subsequent fiscal years.

(5) The use of depot field teams to accomplish depot level maintenance at operational bases is warranted when they can be supported by the bases without affecting support of tactical units. Use of these teams is planned, programmed and budgeted for by the Air Force Logistics Command. Depot level technical assistance and area support to operating bases for the accomplishment of intermediate maintenance is provided when the requesting command certifies that the work is beyond its capability to accomplish.[12]

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[9] U.S. Air Force Regulation 66-1, Equipment Maintenance Policies, Objectives, and Responsibilities, revised 10 January 1969.

[10] U S. Air Force, Air University, Air Force Institute of Technology, School of Systems and Logistics, Handout For Course 210 (DOD), "Why Do We Do It?" AFLC-WPAFB, February 1969, p. 500.

[11] U.S. Air Force, Technical Order 00-25-4, Depot Level Maintenance of Aerospace Vehicles and Training Devices, 15 April 1968.

[12] U.S. Air Force, Technical Order 00-25-107, AFLC Area Support Maintenance Assistance, 15 December 1966.

(6) The Air Force policy on repair of reparables is to achieve repair at the lowest level possible. The Air Force Logistics Command is responsible for determining and publishing the appropriate level of repair for reparable items. This determination is based on complexity of the item, capabilities of repair activities, and overall cost considerations. An appropriate statement in applicable -6 technical orders is used to restrict certain items to depot level repair. Some examples with reasons for restriction to depot level are:

(a) The astro-tracker on the B-52 aircraft is restricted because it is a hermetically sealed unit and requires 35 items of special equipment and higher skills than are normally available at intermediate level.

(b) The LN-12 platform on the F-4 aircraft is restricted because it requires special skills and tools and must be disassembled and reassembled in specially constructed clean rooms.

(c) The turbine rotor used in the TF-33 engine on the C-141 aircraft is restricted because it requires special tooling and skills and expensive balancing equipment available only in engine overhaul activities.

(7) Management procedures have been instituted for the control of reparables at base level maintenance and at depot level maintenance and to provide the inventory manager with worldwide visibility of these assets. These systems are called Due-in-From-Maintenance (DIFM), Management of Items Subject to Repair (MISTR), and Air Force Recoverable Assembly Management System (AFRAMS). For more information on these systems see paragraph 2b below and Chapters XI and XII to this monograph.

2. MAINTENANCE SUPPORT DURING THE VIETNAM ERA

a. General

(1) In-Country

(a) By 1 January 1965, some of the older bases in Vietnam and Thailand which had at first received their assistance from offshore found themselves not only becoming self-sustaining but also providing some assistance to the newer generation of bases. By the end of 1969 all Air Force bases in Vietnam were well established and the quantity and quality of maintenance performed compared favorably with permanent stateside facilities. During the Vietnam era, the evolution from tent cities and open-air work areas to modern, environmentally controlled maintenance shops was completed.

(b) Modern aircraft and their associated electronic systems require test equipment of a highly sophisticated nature and the finest degree of accuracy to maintain them in an operable condition. This test equipment and the tools used to adjust or repair aircraft systems must be kept within certain tolerances or they become useless to the maintenance man. The Air Force has established precision measurement equipment laboratories (PMELs) throughout the world to perform the function of calibrating maintenance equipment. Naturally, no facility existed in Vietnam when units were initially deployed and this function and workload was assumed by offshore support bases such as Clark Air Base. Due to the transportation and packaging costs and the lack of capability while equipment was dispatched for calibration, this function was gradually expanded in-country. Precision maintenance equipment laboratories are now established at Tan Son Nhut, Cam Ranh Bay and a transportation field calibration unit is in place at Da Nang. These laboratories support the calibration requirements of all other bases in Vietnam.

(c) The Air Force has instituted a Spectrometric Oil Analysis Program (SOAP) which is used to forecast jet engine failures by comparatively analyzing consecutive samples of oil from each installed jet engine. Increases in metal content are noted. The amount and type of metal enables the technician to predict failure and to isolate the cause. This program has proven to be very effective but requires a small environmentally controlled laboratory and special equipment to perform the analysis. As with PMEL, these labs were at first nonexistent in

Vietnam. Since the elapsed time between taking an oil sample and providing the analytical results is sometimes critical, it is desirable to have the SOAP lab as close to the base of operation as possible. Therefore, the older bases were first equipped with labs and provided the service to those other bases within their support area. As more labs were obtained they were installed so that all Air Force bases in Vietnam were eventually equipped with SOAP labs. During July, August, and September 1968, a total of 28,078 oil samples were analyzed with a result that 33 engines were removed from service for maintenance correction of incipient failures before actual failure occurred.

(d) Regardless of the quality of maintenance performed on an aircraft, if the ground support equipment is not available or is not usable for loading bombs, starting engines, or providing electrical power or hydraulic pressure for checking the aircraft; then the aircraft is not available to perform its mission. Upon initial deployment to Vietnam most units operated from fields that consisted of little more than a runway and metal matting for aircraft parking and taxiing. As mentioned earlier, this situation gradually improved, but in the meantime operational sorties had to be sustained. The ground support equipment, or aerospace ground equipment (AGE), accompanied the unit on its initial deployment. This equipment, for the most part, was procured along with the aircraft it was designed to support. In the case of the F-100, for example, the AGE was 10 years old at the time of arrival in Vietnam. Operation in dust, mud, rain and sand took its toll, and by midway in the Vietnam era the availability of serviceable AGE was becoming a serious problem. At this time an intensive, theater-wide, AGE corrosion control and rejuvenation program was instituted. This program required that every piece of AGE within the jurisdiction of the Seventh Air Force be completely stripped, repaired, painted, and rejuvenated every 6 months. The magnitude of this program is demonstrated by the fact that there were over 2,250 units of powered AGE alone. To assist in this program an extensive AGE major repair facility was established at Clark Air Base. Individual base maintenance officers detailed additional personnel to their AGE maintenance sections and hired local nationals to perform the more menial tasks of stripping paint and washing equipment. Due to the success of the program, the 100 percent paint/wash requirement every 6 months was terminated in late 1968 with bases directed to revert to the standard wash and paint requirements established in Air Force Technical Order 35-1-3.

(e) The Air Force considered that its needs for vehicular support were quite different from the Army field forces. It was logically assumed that, since aircraft must operate from fixed bases containing hard surfaced runways, taxiways, and aircraft parking areas that the vehicles operating on such a base need not be of the rugged quality needed by the Army for unimproved field conditions. Therefore, the Air Force procured commercial, off-the-shelf type vehicles and instituted a support program for them similar to that of a commercial firm. Maintenance beyond the service station and base maintenance levels was performed by contract and parts were procured through local purchase from commercial vendors. A small percentage of military M-type vehicles was procured for contingency purposes. This concept worked well at stateside and improved overseas locations and proved to be cost effective. Since these vehicles were commercially repaired or overhauled the need for organic depot overhaul capabilities no longer existed and this function was phased out of the depot level support structure.

(f) In Vietnam, the basic assumption that runways, taxiways, and parking aprons must exist for modern jet aircraft to operate proved true. However, the corollary assumption that improved roads would also exist proved fallacious. Squadrons were deployed with commercial vehicles. Upon arrival in Vietnam those vehicles were operated, usually at maximum capacity, around the clock, 7 days per week, in performing the triple function of supporting aircraft missions while at the same time supporting the requirements for constructing an air base and building up a logistics support activity. Not only did these vehicles receive three times the normal usage, but they were operated in an environment of mud, dust, rain, and sand over land that was devoid of even semi-improved roads with constant detours across open country and ditches created by construction activities for the laying of communications, power, water, sewage, and POL lines. The on-board vehicle maintenance personnel were unable to perform little more than service-station maintenance. Users could not afford the loss of a vehicle for preventive maintenance or corrective maintenance on nondisabling malfunctions. As a result the entire fleet deteriorated with vehicles deadlined for parts (VDP) and vehicles deadlined for maintenance (VDM) rates reaching unprecedented heights.[13]

(g) As bases became more permanent and the road situation improved, the utilization and wear-out rates became more normal. However, the deterioration had reached such a state that to bring the fleet back to a condition of good repair was beyond base level capabilities. Area assistance requested from the Air Force Logistics Command was not forthcoming as it had been with the aircraft Rapid Area Maintenance (RAM) and Rapid Area Supply Support (RASS) teams because the depot level skills had been depleted or converted due to the concept of commercial overhaul and repair. What little support AFLC could provide was created from gathering together base level automotive maintenance personnel and depot level personnel with secondary specialties in the automotive area to form support teams. Clark Air Base in the Philippines established a major repair facility for special purpose equipment such as fork lifts and other cargo handling equipment. Replacement programs were expedited and management attention throughout the Seventh Air Force was stringently applied to correction of the problem. Gradually the situation improved, but even at the end of FY 68 vehicle maintenance remained a substantial trouble source.[14]

(2) Offshore

(a) When force deployments began, Air Force units were sent TDY (Temporary Duty) to Vietnam and were supported under the forward operating base (FOB)/main operating base (MOB) concept. The decision to rely on the FOB/MOB concept was based on the critical shortage of the most basic logistic facilities in Vietnam and the extreme distances from established bases. Under this concept, six MOBs in the Far East, which were already stocked and operable, supported the deploying forces. These main bases were located at Clark Air Base, Philippines; Kadena and Naha, Okinawa; and Tachikawa, Yokota, and Misawa, Japan. As of 1 January 1965, there were three FOBs in Southeast Asia which had maintenance detachments assigned. They were located at Bien Hoa, Da Nang, and Tan Son Nhut, Vietnam. Maintenance at the FOBs consisted of remove and replace, and some bench check and repair; field level maintenance being performed at the MOB. As the conflict escalated in late 1965, the policy was changed from TDY deployments to a permanent change of station (PCS) for tactical units. As more units and materiel were deployed, it became increasingly apparent that it was no longer practical to rely on the six MOBs located so far from the deployed units. Shuttling aircraft between the MOBs and forward bases for repairs was excessively time-consuming and wasteful of operational flying hours. Therefore, it was concluded that the system support should be closer to the actual operational bases. In late 1965 and during 1966, MOBs were established in Vietnam and Thailand. These first bases were located at Bien Hoa, Phan Rang, Cam Ranh Bay and Tan Son Nhut, Vietnam; and at Takhli, Ubon, Korat and Udorn, Thailand.

(b) Although the requirement to provide offshore intermediate maintenance for deployed tactical squadrons was phased out rather early in the Vietnam era, there still remained a substantial amount of offshore maintenance support, and more was created as the need arose. C-130 units providing airlift within Vietnam were rotated from their home stations in the Philippines, Taiwan, Okinawa, and Japan. As much maintenance as possible was deferred on these aircraft until they returned to their offshore location, thus reducing the in-country workload.

(C) The recovery base concept used by the Military Airlift Command (MAC) in the Pacific minimized the burden of maintenance, refueling and support requirements in-country. Aircraft inbound to Vietnam from CONUS refueled at Clark, Yokota or Kadena, completed their in-country missions and then returned to one of those same bases for refueling prior to their return flight across the Pacific. The need for only safety-of-flight maintenance and no refueling at forward locations reduced in-country facility and support personnel requirements.

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[13] U.S. Seventh Air Force, Results in the PACAF Command Management System, May 1969.
[14] Ibid.

(d) The location of Strategic Air Command (SAC) B-52 bombers on Guam and Formosa permitted accomplishment of that entire maintenance effort either offshore or in the continental United States.

(e) Prior to the creation of precision measurement equipment laboratories (PMELs) in-country, these programs received support from the established offshore bases. There were eleven PMELs in the Pacific area on 1 January 1965; one each in Hawaii, Guam, Philippines, and Korea, two in Okinawa, and five in Japan. Early in 1965 Clark Air Base extended its precision measurement equipment (PME) courier service to all Southeast Asia bases. The PME inventory at that time numbered 7,000 items. Limited assistance was also provided to U.S. Army, U.S. Navy and Philippine Air Force activities.[15] Two PMELs were operating in Vietnam by June 1967, one at Tan Son Nhut and one at Cam Ranh Bay. A field calibration unit was later established at Da Nang. The existence of these labs greatly reduced Seventh Air Force dependence on Clark Air Base; however, the PMEL at Clark still supports Seventh Air Force requirements that are beyond the capability of in-country PMELs.

(f) Corrosion has always been a maintenance problem, and the environmental and climatic conditions in Southeast Asia created the need for even greater vigilance and corrective measures. The corrosion facility at Kadena was expanded in 1965 and, at the direction of Pacific Air Forces, the Thirteenth Air Force established a center at Clark Air Base to accomplish corrosion control treatment for C-47, C-123, and C-7A aircraft within the theater. Personnel from Vietnam were dispatched to attend corrosion control classes conducted by an Air Training Command Field Training Detachment located at Clark Air Base.

(g) As vehicles and ground support equipment deteriorated beyond the remedial capability of vehicle maintenance activities in Vietnam, a facility established at Clark Air Base was used to assist in the rehabilitation of this equipment. In June 1968, the Pacific Air Forces (PACAF) Vehicle Repair Center at Clark Air Base agreed to process seven additional Seventh Air Force vehicles per month and to repair over 250 component assemblies from Seventh Air Force.[16]

(h) A training program was conducted at Clark Air Base for the upgrading of skill levels in various maintenance specialties. Technical training of maintenance personnel was thus continued even during their 1-year tour in Vietnam by sending them TDY to attend the courses offered at Clark.

(i) Many aircraft received contract depot maintenance such as Inspection and Repair as Necessary (IRAN), modifications to provide improved or new capabilities, and repair of crash/battle damage at offshore locations. Some of these contractors were Air Asia and China Airlines in Taiwan, the Philippines Air Lines in Manila, and Mitsubishi in Nagoya. Offshore contracts of this nature amounted to $16,369,000 in FY 69.[17]

(j) In 1968 the F-4 aircraft developed problems in electrical connections wherein the insulating material, or potting compound, reverted from a solid to a liquid state and lost its insulating ability. It was found that once the compound reversion began, it always continued but at an unknown rate. This phenomenon was particularly susceptible to, and accelerated by, the climate and temperatures encountered in Vietnam. The Air Force Logistics Command was required to find a technical solution to this problem and to provide depot teams to accomplish the correction. Over 4,000 man-hours per aircraft were required to correct this situation on the approximately 700 connectors in each aircraft. For aircraft based in Southeast Asia, repair lines were established at Clark, Misawa, and Yokota, with work accomplished by contract personnel assisted by maintenance teams from Ogden Air Materiel Area (OOAMA).

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[15] U.S. Thirteenth Air Force, History, January-December 1965, "Materiel," Vol. II, Part IV.
[16] U.S. Seventh Air Force, History, 1 January-30 June 1968, Volume I - Part I.
[17] Headquarters, U.S. Air Force, Briefing to the Joint Logistics Review Board, subject: Presentation on Air Force Maintenance, 9 May 1969.

(k) The Air Force Logistics Command utilized the overhaul and IRAN capabilities at Tachikawa for the repair of mobile Ground Control Approach (GCA) radars, Radar Approach Controls (RAPCONS), and vanized Communications, Electronics, and Meteorology (CEM) equipment.

(3) Continental United States

(a) In accordance with Air Force concepts, maintenance support rendered to units in Southeast Asia from the continental United States is provided by the Air Force Logistics Command. Despite the necessary emphasis and increased activity in Southeast Asia, the worldwide effectiveness of Air Force units improved during the Vietnam era. Aircraft, missiles, and equipment, wherever located, were kept at the highest level of operational readiness in Air Force history.

(b) The total number of Air Force aircraft in Southeast Asia increased almost tenfold during the Vietnam era. Of those aircraft lost, 77 percent was due to combat, while the remaining 23 percent was due to operational reasons. The noncombat accident rate in PACAF for maintenance reasons averaged 4.07 percent, which compares favorably to the worldwide rate of 6.2 percent and attests to the high quality of maintenance being performed in the combat environment.[18]

(c) A description of the maintenance support rendered by the Air Force Logistics Command to the Southeast Asia effort is contained in paragraph 2g, Support Forces.

b. Reparables

(1) Resulting from the increased activity of Air Force Units during the Vietnam era, the requirements for spare parts increased beyond the requirements calculated from previously planned activity rates. Long procurement lead times for some items precluded solution in the immediate future through procurement of additional spares. Since the most expeditious and economical means of obtaining resupply support is by repairing unserviceable items and placing them back in service, it was to this area that management turned its attention. If repair cycle times could be reduced, total spares requirements would also be reduced.

(2) To accomplish this reduction of assets in the repair pipeline, three separate but interlocking programs were instituted. At base level, the Due in From Maintenance (DIFM) program ensures that intermediate level maintenance activities expedite the determination of whether or not items can be repaired at this level. For those items that can be repaired on base, the DIFM program provides visible evidence to managers in those cases where repairs exceed time standards or where delinquencies exist in returning items to supply within established time limits. For those items determined to be beyond the capability of the base to repair, the DIFM program contains time standards which require expeditious turn-in to supply for immediate shipment to a depot level activity where the items enter the Management of Items Subject to Repair (MISTR) system.

(3) The MISTR system was implemented in July 1965 and was used in accomplishing the FY 66 depot material repair requirements. It is designed to provide a biweekly projection of those items requiring immediate repair to satisfy supply demands. It also provides a long range projection of logistics annual repair requirements for use in the preplanning and establishment of repair sources. All recoverable expendable (XD) and recoverable nonexpendable (ND) depot level repair items including those repaired by commercial contractors or other government activities, and local maintenance generated repair requirements are included and processed in the MISTR system. Every 2 weeks, the system computes and updates the quantity of each recoverable item requiring repair during the next 4-week period based on current customer demands. The urgency of need of these requirements is identified by a repair precedence. Repair precedence 1 includes all MILSTRIP priority 01 through 03 back orders. Repair

[18] U.S. Air Force Accident Bui ., subject: Aircraft Accidents (U), 1968 (CONFIDENTIAL).

precedence 2 includes all MILSTRIP priority 04 through 20 back orders plus one-half of the MISTR computed depot (wholesale) stock level requirement. Repair precedence 3 includes the other one-half of the depot stock level requirement plus administrative lead time and shop flow time.

(4) Air Force Recoverable Assembly Management System (AFRAMS) was developed to provide central daily knowledge of authorized levels and assets by location, condition, and actual intransit quantities. This system permits more effective redistribution of assets and the balancing of assets across bases during periods of asset shortage. Through this centralized knowledge of worldwide asset location and condition, the AFRAMS enables managers to have meaningful surveillance over worldwide assets of recoverable items, including the base and depot repair cycles. The satisfactory Not Operationally Ready—Supply (NORS) rates achieved during the Vietnam era attest to the value of these programs. AFRAMS was instituted on 1 November 1967 after more than 2 years of planning and development by AFLC. As of 1 January 1970 there were over 163,000 items for a dollar value of over $6 billion in the AFRAMS system.[19]

c. Maintenance Personnel

(1) Factors and standards used in computing manpower resources and skills necessary to support an Air Force base maintenance complex are published in two Air Force manuals:

Air Force Manual 26-1, Manpower Policies, Procedures and Criteria, 7 September 1962.

Air Force Manual 26-3, Manpower Criteria and Standards, 8 May 1969.

(2) The Air Force associates functions to flying hour programs; this permits standardization of manning criteria among bases supporting identical weapon systems. Some latitude is granted to subordinate commands to adjust within their total authorizations.

(3) All units in Southeast Asia were manned at, or very close to, 100 percent of authorized strength in the aircraft maintenance area. Personnel in the higher grades and with high skills were usually provided in greater numbers than authorized. This accomplishment was at the expense of stateside units but ensured an organic maintenance capability commensurate with the requirement in Southeast Asia. Contract maintenance at organizational and intermediate levels was therefore limited to the hiring of local nationals for performing menial tasks and to Contract Engineering Technical Service Representatives who provided expert advice on the equipment furnished by their employer.

(4) Table 38 depicts the maintenance manning and skill distribution of the F-4 equipped 12th Tactical Fighter Wing at Cam Ranh Bay in June 1967.[20] Eighty-three Republic of Vietnam nationals were also authorized and performed such tasks as washing and stripping paint from aircraft and aerospace ground equipment and performing routine manual labor in the munitions storage area. By contrast, the 4th Tactical Fighter Wing, also equipped with F-4 aircraft and located at Seymour Johnson Air Force Base in North Carolina, was manned in the maintenance area at 69 percent of authorized strength in April 1969.[21] Both wings are considered representative samples.

[19]Headquarters, Air Force Logistics Command, FY 71-1 DO-41 Computation (CSIS): Central Secondary Item Stratification Report, 31 December 1969.

[20]Headquarters, Air Force Logistics Command, Project PACER SORT, Special Overseas Repair Test, Final Report, Vol. I, Part IV, PACER SORT Task Force, Wright-Patterson AFB, 30 June 1967, pp. I-IV-5-7 and I-IV-5-9.

[21]U.S. Air Force, 4th Tactical Fighter Wing, Monthly Maintenance Analysis, RCS K-18 Part I & II, April 1969.

TABLE 38

TWELFTH TACTICAL FIGHTER WING MAINTENANCE
MANNING AND SKILL DISTRIBUTION

Grade	Auth	Assigned	Skill	Auth	Assigned
E-9	14	18	9	37	68
E-8	23	37	7	355	585
E-7	89	106	5	1,158	1,601
E-6	266	260	3	618	207
E-5	476	446			
E-4	682	762			
E-3	618	691			
E-2		137			
E-1		4			
Total	2,168	2,461	24	2,168	2,461

(5) Such favorable manning was not the case in Southeast Asia in the vehicle maintenance area where severe shortages occurred in both numbers of personnel and in skill levels. In one instance during 1968, the mechanics-per-vehicle equivalents ranged from 1 per 18 to 1 per 20; the manning standard was 1 per 14.5.[22]

(6) As the units in Southeast Asia grew in number to meet increasing requirements, it soon became apparent that some personnel policies needed revision. One-year tours and no second tours until everyone had had an opportunity to serve in Southeast Asia created numerous problems. The establishment of permanent units in Southeast Asia solved some personnel problems but created others, as many individuals who had served tours in a TDY capacity now found themselves accompanying their unit on a permanent change of station move. Personnel rotation schedules had to be arranged so that all experienced people did not rotate at the same time. Maintenance was also affected by these problems. While the Air Training Command could give new personnel their basic training, it was necessary to assign them to, or at least process them through, the Tactical Air Command in order to expose them to the aircraft and equipment in use in Southeast Asia and to increase their skill level. Tactical Air Command thus became very much involved in personnel training in support of Southeast Asia operations.

(7) Imbalances were developed in certain skills due to the greater need overseas than in the Zone of Interior. The impact of such ratios on rotation and training policies were severe and many innovations were adopted to achieve an adequate flow of replacements.

(8) Depot level Civil Service personnel provided assistance in three general areas. Rapid Area Maintenance (RAM) teams provided a ready source of area maintenance capability from highly skilled depot resources. Personnel registers established with the AFLC Air Materiel Areas identified personnel in fifteen major skill areas who had volunteered to deploy on 18-hours notice to support emergency-type maintenance requirements such as repair of crash/battle damaged aircraft overseas. (See paragraph 2g for more information on RAM teams.) The AFLC AMA assistance program included the establishment of installation and checkout (I&C) teams to accomplish the interface between shop facilities and shop equipment at Southeast Asia

[22] U.S. Seventh Air Force, History, 1 January-30 June 1968, Volume I - Part I.

bases. Five teams of 12 men each accomplished this function at 17 bases. Civil Service personnel with automotive maintenance experience were dispatched to assist in the Southeast Asia vehicle maintenance program. (Additional information is provided in Chapter X, Maintenance Manpower.)

d. Tactical Forces

(1) On 1 January 1965 all Air Force organizational and intermediate level maintenance activities were similar, in conformance with the organizational management and procedural guidance provided in Air Force Manual 66-1. In Vietnam, the consolidated maintenance system was the same as that in-being at Air Force fixed installations in the continental United States, with one exception: under the main operating base (MOB)/forward operating base (FOB) concept, the majority of intermediate maintenance was being performed at Clark Air Base in the Philippines. The MOB/FOB concept was the method of operation of Tactical Air Command contingency planning which called for only those functions being performed at forward bases absolutely essential to combat effectiveness and unable to be performed elsewhere. Pacific Air Forces (PACAF) published a supplement to Air Force Manual 66-1 in which certain bases were designated as MOB or FOB for each type of aircraft to be deployed. PACAF levied the responsibility on MOBs to maintain an operationally ready (OR) condition of at least 80 percent of the aircraft deployed to FOBs.

(2) By 1 January 1965 the MOB/FOB concept was beginning to change as forward base and tactical unit commanders pressed for increased capability, self-sufficiency, and improved materiel reaction time. This expanding maintenance capability at forward bases generated increased in-country maintenance facility and personnel requirements which, in turn, created the need for more indirect support activities. Thus by 1 January 1965 the first steps had already been taken toward creation of self-sufficient air bases with all the attendant facilities that are required to operate such an establishment. As bases became more self-sufficient, maintenance personnel were severely handicapped, not only by lack of shop and hangar space, but by extremely congested ramp areas. Workloads in-country were greatly increasing. For example, almost 5,000 transient aircraft were supported at Da Nang in the first 6 months of 1965 which was more than double the transient traffic during the previous 6 months. Environmental conditions, battle damage, and munitions loading increased the maintenance man-hours per flying hour. On the A-1E in 1965, the ratio was 17.6 man-hours per flying hour as contrasted to the Air Force standard of 10 hours. This factor, combined with the tremendous increase in flying hours, provided a real challenge to the maintenance man. In spite of this workload, OR rates of fighter and reconnaissance aircraft in 1965 were consistently above the Air Force standard except for the F-4C which was plagued with spare parts problems during this initial period of deployment. These accomplishments are a tribute to the skill and dedication of Air Force maintenance personnel at all levels who managed somehow to get the job done even under the most adverse of circumstances.

(3) Some organizational changes were taking place that might have been indicators of changes to come. On 8 July 1965, the 2nd Air Division at Tan Son Nhut was removed from the Thirteenth Air Force chain of command and placed directly under the Commander in Chief, Pacific Air Forces. To better cope with the expanding maintenance problems in the aircraft armament area, an Armament Maintenance Division was organized in November 1965 within Headquarters, 2nd Air Division.

(4) An innovation in the method of performing maintenance on aircraft took place near the end of 1965 when a phase inspection program was initiated. This new concept divided inspection requirements into smaller work packages which decreased aircraft out-of-commission time for the performance of periodic inspections.

(5) The buildup of 1965 began in February, but it was not until November that the first permanent (PCS) fighter squadrons reached Vietnam. The major feature of the maintenance story in 1966 was the growth of the forward bases and their transformation to main operating bases. In April 1966 the 2nd Air Division was redesignated the Seventh Air Force; the Directorate of Maintenance then became more and more involved in establishing mutual support arrangements among the various maintenance activities in Southeast Asia.

(6) The concept of maximum base self-sufficiency resulted in a mass movement and construction of maintenance facilities in Vietnam. This buildup led to a questioning of the self-sufficiency concept and, as a result, the Chief of Staff, USAF, authorized a test to evaluate the impact of reducing maintenance repair workloads in a combat environment.[23] Project LOGGY SORT, later renamed PACER SORT, was conducted at Cam Ranh Bay on the F-4 aircraft during the first half of 1967. This project was designed to test the mission effectiveness in a combat environment of forward area versus rear area maintenance of reparables.[24] Much useful data were collected during Project PACER SORT but, due to the inability to apply rigid test disciplines and due to external influences caused by the combat environment, the results were inconclusive. It can be deduced from this effort, however, that changing basic support concepts during a military conflict is not feasible. It appears that these changes must be made in peacetime so that in-being procedures can continue to be used and applied to the combat situation.

(7) The construction of shops, hangars, and laboratories, intended to ease the offshore workload and provide increased in-country self-sufficiency, experienced difficulty in keeping pace with the buildup and increases in air activity. From January 1966 until June 1967, the Seventh Air Force in-country aircraft increased by 67 percent and in the first 3 months of 1967; the number of transient aircraft arriving at Bien Hoa increased 27 percent.[25] Operationally Ready (OR) rates provide a good standard for measuring maintenance effectiveness. It is interesting to note that during this same 18-month period of expansion, the Seventh Air Force aircraft bettered the U.S. Air Force OR standard every month.[26] The amount of munitions expended, and therefore stored, handled, inspected, assembled, transported, and loaded on aircraft by munitions maintenance personnel, between January 1967 and September 1967 exceeded the tonnage of munitions expended during the entire Korean War.

(8) Lack of reliability in the weapon release systems of Air Force fighter-bomber aircraft resulted in considerable unexpended ordnance. Local procedures were developed in Southeast Asia which involved impounding of aircraft after experiencing hung ordnance or inadvertent release difficulties. Impounded aircraft were thoroughly inspected and tested by the most qualified maintenance personnel in attempts to duplicate the malfunction, find the cause, and correct the problem. Due to lack of adequate maintainability features, malfunctions often could not be duplicated. When this occurred the only recourse was to replace those components which could have caused the malfunction of the system. Each instance required the preparation of detailed reports for local and higher headquarters' analysis and evaluation. These procedures, though necessary, were extremely costly in terms of skilled maintenance man-hours, aircraft availability, and procurement of additional spare components. Sufficient justification to warrant increased attention to simplicity and ruggedness of design and to maintainability and reliability features of weapon release systems is available from Air Force experience in Southeast Asia. For example, on three major weapon systems, over 11,000 instances of hung ordnance were documented from May 1968 through January 1970.[27]

(9) During the latter part of the Vietnam era, construction of maintenance facilities and installation of equipment progressed to a point where Southeast Asia maintenance capabilities rivaled those at stateside bases. While combat sorties and aircraft utilization rates reached an all-time high and were sustained at this rate, the accident rates attributable to maintenance were lower in the Pacific area than those for the Air Force worldwide. An example of the high caliber of maintenance performed in Southeast Asia is the 131,395 hours flown in 127 months without a flying accident by a reconnaissance squadron.[28] Other unit records are equally impressive. Operational requirements, battle damage, and environmental conditions all played a part in making the maintenance workload in Southeast Asia the highest ever experienced on a sustained basis. The records show that this workload was accomplished with no degradation to safety or to combat ready aircraft.

[23] Headquarters, U.S. Air Force, Test Order 66-27, 11 January 1967.
[24] Headquarters, U.S. Air Force Logistics Command, Project PACER SORT, 30 June 1967.
[25] U.S. Air Force, History, 1 January-30 June 1967, p. 148.
[26] Ibid., p. 165.
[27] Commander in Chief, Pacific Air Forces, Message P 130403f, March 1970 (CONFIDENTIAL).
[28] U.S. Air Force, 347th Tactical Fighter Wing, History, April-June 1969, Volume I, p. 89.

e. Airlift Forces. There are basically three kinds of airlift: strategic, tactical, and organic. Strategic airlift is global in nature and is controlled and operated by the Military Airlift Command (MAC). A large percentage of the MAC fleet, augmented by contract airlift, was devoted to the deployment and resupply of units in Southeast Asia from the continental United States. Tactical airlift is provided by Tactical Air Command (TAC) and is composed of aircraft committed to overseas areas coming directly under the control of unified commanders. These aircraft perform day-to-day support of deployed ground and air forces in that area. Organic airlift is provided by small cargo and passenger-carrying aircraft assigned to, and fully utilized by, the unit. Fighter wings in Vietnam were usually assigned one C-47 for this purpose.

(1) Strategic Airlift

(a) With the advent of the Vietnam conflict, the dependence on global airlift reached new proportions and at one time over 85 percent of MAC's entire airlift effort was directed in support of Southeast Asia. The Air Force concept of no overseas depots and single point repair forced reliance on responsive strategic airlift.

(b) The airline type of operation of MAC which accumulated many flying hours and few sorties indicated the need for an inspection system diametrically opposed to the phased inspection system developed for fighter aircraft which accumulate relatively few flying hours but many sorties. It was determined that the method of inspecting aircraft should be tailored to the type of operation of that aircraft. While it is axiomatic to state that inspections take time which detracts from operational availability it appeared to MAC that there should be a "best" way of inspecting aircraft that would provide high air worthiness and reliability in the minimum downtime. With aircraft averaging 220 flying hours per month, scheduled inspections based on flying hours proved impractical and the isochronal inspection concept was developed. This concept, based on elapsed calendar days rather than flying hours, was service tested on the C-141 during the latter half of CY 66 at Travis Air Force Base. The concept was fully implemented on the C-141 on 1 December 1966 and other MAC aircraft were phased in during the next 2 years. The isochronal concept enables more efficient scheduling of the work force, provides an even workload flow, and, by use of repetitive tasks, assists in making inexperienced airmen more productive. This inspection concept enabled MAC to reduce the maintenance manning factor from 20 to 18 man-hours per flying hour which equates to a saving of 1,404 manpower spaces.

(c) Since a large portion of the MAC airlift fleet is away from the home station, it is necessary that these aircraft be supported at en route locations. In order to expeditiously move this force through these locations, procedures were developed which permit concurrent on and offloading, refueling, and performance of necessary minor maintenance. Some of these stations have little or no maintenance capability. Therefore maintenance recovery teams were established and equipped with special tools and equipment. These recovery teams are strategically located so that they can be rapidly dispatched to any location within their geographic area of responsibility. There also are support units located along the MAC route structure. The size of individual units depends upon forecast landings at specific locations. For example, Goose Bay is manned with 54 people and supports 75 landings per month, whereas Yokota is manned with 430 people and supports over 1,700 landings per month.

(d) The introduction of the C-141 into the MAC inventory in April 1965 provided a tremendous boost to MAC's airlift capability throughout the Vietnam era. During this time the aircraft's inherent airworthiness and reliability permitted the overhaul (IRAN) interval to be extended from 2 to 3 years. MAC had planned a buildup to a 5-hour utilization rate 1 year after activation. The first three squadrons continued the buildup rate to 5 hours as originally planned, with an increase to 8 hours two quarters later. All other squadrons were programmed to achieve the 8-hour utilization rate 1 year after activation. The acceleration in C-141 production and utilization rates to support Vietnam airlift requirements saturated depot level capacity and necessitated multishift operation and large expenditures of overtime at Warner Robins Air Materiel Area (WRAMA). A contract field team was established at Travis Air Force Base. This team accomplished a little over one million man-hours of modification and update work. As of 30 April 1969, the C-141 had established a rather impressive record as an aeromedical vehicle as well as a passenger and cargo carrier, as evidenced by the following data:

Total force time	1,576,988 hours
High time aircraft	14,221 hours
Mechanical reliability	96.0 percent
Utilization rate	8 hours

(e) The importance of global airlift was accentuated when, on 1 January 1966, the Military Air Transport Service (MATS) was redesignated the Military Airlift Command (MAC).

(2) Tactical Airlift

(a) Cargo and passengers arrive in Vietnam by way of ships and both military and commercial aircraft. Within Vietnam, however, climatic and topographical conditions frequently stymie surface transportation and make airlift the only feasible means of distributing goods and people from air and sea ports to their ultimate in-country destination. In addition to routine airlift, numerous unscheduled resupply missions are flown by Air Force Air Commando units in support of Army, Marine Corps, Vietnamese, and other Free World outposts or operations. Special missions, including defoliation, flare drop, and psychological warfare were consuming 1,800 sorties per month in 1967.

(b) Numerous organizational changes occurred in 1966 due to the expanding role and increase in strength of tactical airlift units. Among these were the redesignation of the 315th Air Commando Group to the 315th Air Commando Wing and the subsequent transfer of this wing from the 315th Air Division at Tachikawa, Japan, to the 834th Air Division under operational control of Seventh Air Force. As airlift units expanded, the base maintenance self-sufficiency concept developed parallel to that described for tactical forces, except that C-130 aircraft continued on a temporary duty basis to Vietnam from their offshore bases. This action tended to lighten maintenance and other support pressures in-country which were hard pressed in 1966 when Tan Son Nhut became the busiest single strip airport in the world. Airlift records in 1966 alone surpassed the airlift of 697,000 tons during the Korean War. Air Force combat cargo crews logged their millionth ton of airlift support in November of that year. During 1966, the C-130 HERCULES aircraft, manned by crews on rotational duty from the Philippines, Taiwan, Okinawa, and Japan, provided more than two-thirds of all in-country airlift. In early 1967, airlift records were set so often that it became impossible to keep up with them. One of the seldom recognized functions of maintenance is the turnaround of aircraft which consists of meeting, parking, servicing, and restarting of the aircraft as they arrive and depart an air base. An indication of this workload can be realized by the 1,600 takeoffs and landings which occurred per day at Tan Son Nhut during 1966. Efficiencies in the turnaround of aircraft are great contributors to the establishment of airlift records.

(c) On 1 January 1967, the Air Force officially took over the Army CV-2 CARIBOU (called C-7A by the Air Force). The resources available to the 834th Air Division from then on averaged 240 aircraft of three types. Aircraft resources included a C-7A wing with six squadrons, a C-123 wing with five squadrons and three C-130 detachments rotated from offshore bases. Airlift aircraft were bedded down at eight major bases through Southeast Asia.

(d) By June 1967 the deployment of maintenance units reflected the varied missions performed. While the USAF jet-capable bases had the three-squadron maintenance structure—Field, Armament and Electronics, and Munitions—the two wings of the 834th Air Division had their own Consolidated Aircraft Maintenance Squadrons (CAMRONs) at Tan Son Nhut and Cam Ranh Bay. The phased inspection concept, revamped from the older periodic maintenance system was applied to tactical airlift as well as to tactical fighter aircraft.

(e) The Vietnam era produced the largest sustained tactical airlift in history. In terms of gross statistics, the total airlift tonnage in cargo and passengers hauled in 1968 was 25 percent greater than in 1967. Total monthly sorties increased from an average 32,000 in 1967 to over 38,000 in 1968. Overall, the maintenance operational statistics reflected an outstanding performance. Reliability factors such as initial launch, OR, NORS, and NORM rates all remained well within Air Force standards.

f. Strategic Forces

(1) On 18 June 1965, the Air Force added another dimension to its combat air power as 28 Guam-based B-52s dropped more than 500 tons of conventional 750-pound bombs on an enemy troop staging area in South Vietnam.

(2) The Strategic Air Command (SAC) had operated a reflex force of B-52 aircraft from Andersen Air Base on Guam prior to 1965. Therefore, facilities were already available and could be expanded to support the Vietnam (ARC LIGHT) operation. Thus, Andersen Air Base became a main operating base (MOB) which supported its own B-52 aircraft and later provided MOB support to B-52 aircraft deployed to forward operating bases (FOBs) at U-Tapao, Thailand, and at Kadena, Okinawa.

(3) Prior to ARC LIGHT, SAC had no requirement to deliver large quantities of conventional munitions. Consequently, neither existing SAC concepts nor the B-52 aircraft systems were designed for the task. Since increasing the internal bomb carrying capability of the B-52 appeared to be the only feasible method of putting more bombs per aircraft on the target, modification of the aircraft and reorientation of concepts were necessary.

(4) Providing increased conventional bomb carrying capability in the B-52 required structural reinforcement of the bomb bay area to accommodate the heavier load configuration and new structure and fittings for carriage of the new clip-in bomb racks. Engineering Change Proposal (ECP) 1224-7 authorized the BIG BELLY modification of 155 B-52D aircraft for conventional munitions. This modification increased the conventional munitions carrying capability of the B-52 from 51 bombs to 108 bombs. By the end of February 1966, the Oklahoma City Air Materiel Area (OCAMA) had expended $31,323,000 on modifications and maintenance for the B-52s in Southeast Asia. This amount increased to $78,935,900 by the end of CY 67. The actual modification work was accomplished at the San Antonio Air Materiel Area, one of the B-52 specialized repair activities.

(5) Once the B-52 aircraft were modified, the maintenance support was provided in a routine manner. Increases in workload were compensated for by applying standard man-hour per flying hour factors which resulted in increased maintenance personnel authorizations against which personnel were provided. The increased bomb carrying capability combined with an increased number of sorties posed the same kind of bomb handling problems as previously described for fighter aircraft. However, because of the relatively standard bomb configuration of the heavy bomber and with the introduction of clip-in racks, management procedures were able to alleviate this problem considerably. Personnel from other less critical areas were trained in bomb handling and assembly procedures. The increased requirement for vehicles, trucks, flatbed trailers, forklifts, and tools was satisfied by shipment of assets from the CONUS.

(6) During early 1966, the production line method of bomb assembly was initiated. This method incorporated the use of a large shed-type building which could accommodate up to five bomb trailers at one time. Special tools were fabricated, some utilizing air-driven power equipment. The approximate 13 component parts required to completely assemble a conventional bomb were now delivered to the one centralized bomb assembly point. This procedure, combined with the clip-in bays, permitted a preload capability to be developed.

(7) In addition to the B-52, the SAC aerial refueler KC-135 played a major role in Vietnam. Not only did this tanker support SAC aircraft, but it was needed to refuel deploying aircraft and fighter and reconnaissance aircraft during combat sorties in Southeast Asia. As this program, called YOUNG TIGER, developed, support units were created and expanded, SAC wings and the 3rd Air Division were created at Andersen Air Base and Kadena Air Base. Soon after, SAC units were created in Taiwan and Thailand. To satisfy the resultant airlift requirement, the deploying YOUNG TIGER KC-135s were utilized to transport critical cargo and passengers as a secondary role.

(8) The OCAMA maintenance downtime requirements for performing scheduled modifications and IRAN on the KC-135 were whittled from 35 to 26 days. This reduction put SAC's tankers back into Southeast Asia operations almost 25 percent sooner.

g. Support Forces

(1) In the context of this paper, support forces are those forces that are assigned to the Air Force Logistics Command excluding supply, maintenance, transporation, and other support activities assigned to using or operating commands. Therefore, this paragraph pertains to the support rendered by AFLC through its AMAs to those commands directly involved in the Southeast Asia conflict. The dollar values of depot facilities, equipment, personnel, and contracts for FY 65 through FY 69 are shown in Table 39.

(2) Depot level maintenance workload can be divided into those that are programmed and those that are unprogrammed. Programmed workloads are those that can be foreseen and anticipated with the result that funds and manpower can be allocated accordingly. Examples of programmed workloads are: aircraft modification and IRAN programs, engine and accessory overhaul, and the repair of reparables. Unprogrammed workloads are those that occur with little or no warning that require manpower and funds, the expenditure of which had not been anticipated. Examples are: precipitous structural failures affecting a fleet of aircraft, drastic decrease in time-between-failure of engines or components, and an unanticipated rise in condemnation rates of reparables.

(3) The rise in flying hours and other activity rates resulting from increased Air Force participation in Southeast Asia caused a commensurate increase in depot level programmed workloads. The total depot maintenance support for FY 69 rose to 128.9 million direct man-hours from 120.7 million in FY 68. In FY 67, 22 million direct man-hours were expended on the B-52, 5.3 million on the KC-135, and 4.8 million on the F-105.

(4) While these and similar workloads caused management problems, they were not nearly as severe as four major unprogrammed workloads which occurred in 1967 and 1968. Continuous short field landings and takeoffs on rough, debris-strewn runways with aircraft operating at high gross weights because of short sortie lengths greatly accelerated metal fatigue on the C-130 so that cracks developed in the upper surface of the center wing panels and in the main landing gear mounting brackets. This created a major repair project in 1967 on an aircraft that was already 10 years old at the start of the Vietnam era. A contract team from Lockheed, the manufacturer of the C-130, and technicians from WRAMA surveyed the fleet and determined the extent of repair needed to correct the fatigue problem. As a result all C-130B/E aircraft are being phased through the Lockheed plant at Marietta, Georgia, for the structural portion of the wing modification.

(5) Another aircraft of early vintage was the F-100. As a result of continued extensions of programmed phase-out dates it became war-weary and also developed cracks in the wings, the most serious of which was in the wing center box section. An engineering fix was developed and published as Time Compliance Technical Order (TCTO) IF-100-1028. This was a depot level modification and was accomplished mostly by field teams dispatched to Vietnam. Engineering fixes were developed for other areas of wing cracks and these also were accomplished by field teams. In some cases it was necessary to replace wings in the field and rotate cracked wings through repair facilities in the continental United States. TCTO 1028 was completed in 1969 but repair of the other wing cracks prescribed in TCTO 1035 is still in process.

(6) In mid-1968 the C/KC-135 developed a structural problem in the tail assembly which required immediate attention because of safety of flight implications. The entire fleet of 767 aircraft was processed in 52 days by OCAMA at a cost of 129,000 unprogrammed man-hours. The cost of this fleetwide modification was over $1 million and emphasizes the need for maintaining a capable and responsive organic depot maintenance organization with sufficient knowledge and surge capability to be able to respond to emergency situations.[29]

[29] Department of the Air Force, Briefing to the Joint Logistics Review Board, subject: Air Force Maintenance System, 9 May 1969.

TABLE 39

DEPOT MAINTENANCE STATISTICS

SUMMARY	FY 65	FY 66	FY 67	FY 68	FY 69
Sq. Ft. Available	13,339,960	13,283,015	13,406,597	13,824,908	13,891,141
(Phase-out AMAs)	(4,200,000)	(3,000,000)	(3,000,000)	NA	NA
Value of Facilities	$244,900,000	$244,000,000	$248,300,000	$259,000,000	$262,500,000
(Phase-out AMAs)	($82,100,000)	($52,800,000)	($52,800,000)	NA	NA
Value of Inst. Equip	$260,200,000	$269,000,000	$277,300,000	$329,100,000	$382,300,000
(Phase-out AMAs)	NA	NA	NA	NA	NA
Organic M/H[1] (AMAs)	46,280,692	48,593,201	52,211,201	48,856,936	51,364,708
Organic Costs	$391,400,000	$411,500,000	$450,200,000	$461,300,000	$712,400,000
Contract M/H	27,780,618	35,513,084	49,671,479	60,062,391	67,766,481
Contract Costs	$287,200,000	$327,400,000	$476,900,000	$491,400,000	$781,100,000
Interservice-Org. M/H	286,265	324,045	379,213	309,225	398,542
Cost	$1,500,000	$2,100,000	$3,200,000	$2,700,000	$3,600,000
Interservice-Con. M/H	292,413	217,739	222,947	219,085	361,789
Cost	$2,000,000	$1,400,000	$1,500,000	$1,600,000	$3,100,000
IS[2] for AFLC M/H	1,785,094	2,127,037	2,957,336	3,203,316	4,681,213
Cost	$16,300,000	$20,700,000	$26,000,000	$26,700,000	$48,700,000
MASDC[3] M/H	449,800	603,200	637,600	628,900	715,556
Cost	$2,900,000	$4,300,000	$4,200,000	$5,000,000	$5,500,000
Org. Maint. On-Site (For GEEIA[4]) M/H	1,530,524	1,733,535	1,583,984	1,104,737	1,237,270
Cost	$10,500,000	$11,800,000	$11,200,000	$8,100,000	$9,400,000
Con. Maint. On-Site (GEEIA) M/H	450,000	340,000	310,000	310,000	260,000[5]
Cost	$4,500,000	$3,400,000	$3,100,000	$3,100,000	$2,600,000[5]
Organic					
M/H	46,280,692	48,593,201	52,211,201	48,856,936	51,364,708
Cost	$391,400,000	$411,500,000	$450,200,000	$461,300,000	$712,400,000[6]
Contract					
M/H	27,780,618	35,513,084	49,671,479	60,062,391	67,766,481
Cost	$287,200,000	$327,400,000	$476,900,000	$491,400,000	$781,100,000[6]
TOTAL					
M/H	74,061,310	84,106,285	101,882,680	108,919,327	119,132,189
Cost	$678,600,000	$738,900,000	$927,100,000	$952,700,000	$1,493,500,000[6]

[1]Man-hours.
[2]Interservice.
[3]Military Aircraft Storage and Distribution Center.
[4]Ground Electronics Engineering Installation Agency.
[5]Non-Depot Maintenance Industrial Fund (DMIF) money.
[6]Includes GFM and FWF; excludes Non-DMIF, Technical Data, Calibration, etc.

Source: Mr. Frank L. Lodge, Presentation on The Air Force Maintenance System, Headquarters USAF (AFSMEPB) to the Joint Logistics Review Board, 9 May 1967.

(7) The F-4 potting compound reversion problem was a back-breaker of unprogrammed depot workloads. Here was a first-line modern fighter aircraft with problems that required extensive downtime and thousands of skilled man-hours to correct. This project cost over $5 million in unprogrammed funds.

(8) Probably the most lucrative pay-off of depot support to Vietnam was the extension of the area assistance program into teams of specialists dispatched to Southeast Asia to repair crash or battle damaged aircraft. These teams were called Rapid Area Maintenance (RAM) teams and began functioning in April 1964. In May 1965, PACAF published regulation 66-24 which directed units at an FOB to request AFLC assistance when they possessed an aircraft with sufficient damage to require more than 5 days' work. The RAM team assistance concept was used throughout the era to perform any repair or modification to aircraft within the theater beyond the capability of using activities. Often these specialists, experienced in the type and model of aircraft suffering damage, were able to return it to serviceable condition or to accomplish emergency repairs which permitted the aircraft to be flown to a major repair facility. When an aircraft could not be repaired or made flyable, the RAM team would either disassemble and crate it for shipment to a repair facility or, if this was not economically feasible, the aircraft would be salvaged to retrieve serviceable parts. As of 25 November 1969, RAM teams had processed 1,120 aircraft of which 881 were repaired on site, 87 were prepared for a one-time flight to a repair facility, 127 were prepared for shipment to a repair facility, and 25 were salvaged. The acquisition value of those aircraft repaired or prepared for shipment or one-time flight is $1,779,020,480. It is interesting to note that, of aircraft repaired on site, the F-4, F-100, and F-105 consumed the most man-hours. The highest consumers for one-time flight were the F-105, the F-4, and the C-130; the F-4 was the largest expenditure of man-hours for preparation for shipment. According to Headquarters, AFLC, 20 percent of all F-4 aircraft encountering battle damage beyond base level capabilities had to be shipped to CONUS for repair. This demonstrates that the modern, more sophisticated aircraft will require more extensive repair subsequent to battle damage than the older fighter aircraft. In December 1967, the Air Force Logistics Command organized Combat Logistics Support Squadrons (CLSS) composed of military personnel to perform this task. Presently, there are five CLS Squadrons with 1,208 people assigned. These units are trained in depot level technical and procedural methods at the various Air Materiel Areas. The military ceiling in Vietnam hampered the use of these squadrons.

(9) In addition to those described above, AFLC provided a multitude of separate support actions in the maintenance area too numerous to describe in detail. Among them were the Weapon System Liaison Officer Program, the Technical Representative Program, area assistance in vehicle, cargo handling equipment, communications electronics equipment, technical and engineering assistance, and Installation and Checkout Teams. The ability to provide quick response to the needs of operational units in all areas of maintenance was repeatedly demonstrated.

3. CHANGES, PROBLEMS, AND CORRECTIVE ACTION IN MAINTENANCE SUPPORT DURING THE VIETNAM ERA

a. General. While there were no major changes in Air Force maintenance policies or procedures during the Vietnam era, there were deviations and changes at operating levels due to pressing needs in the combat environment. There were lessons learned that may influence future Air Force maintenance policies and procedures. Some of these actions are described in this paragraph. The lessons learned appear in paragraph 4, which follows.

b. Maintenance Data. In January 1965, a program was established to segregate and separately analyze AFM 66-1 maintenance data and AFM 65-110 readiness data for weapon systems being used in Southeast Asia. Prior to the establishment of this program, the data from Southeast Asia lost its unique combat environment character by being merged with all other data. The data are now available for details concerning specific logistic support in that theater. The soundness of this decision is evidenced by the wealth of maintenance and performance data documented by deployed units. These data have provided much valuable information to system and item managers.

c. Depot Support

(1) A potentially dangerous situation faces the Air Force through continuous deferral of depot maintenance over the past few years. As of October 1968, AFLC reported that this deferred effort amounted to over $285 million.[30] The rigorous conditions involved in Southeast Asia and the variety of configurations adopted for specialized operations will result in an undetermined depot maintenance workload upon completion of that conflict. (For a complete study of deferred maintenance, its cause and effects, see Chapter VII, of this monograph.)

(2) A consequence of priority workloads and cutbacks in the civilian work force is the continued deterioration of the organic depot maintenance capability with increased reliance on contractor support. In FY 69 the organic work force satisfied less than 50 percent of the FY 69 depot maintenance requirement. Since the organic maintenance facilities are manned and workloaded with the highest priority mission essential work, the organic program has been funded 100 percent within the current program availability, the remainder being applied to contract programs. Department of Defense directives specify the need for an organic capacity sufficiently flexible to overcome the threat of possible contractor work stoppages as well as shifting employment/deployment concepts of major Air Force Commands and their attendant high response demands for depot and field team support. While this fundamental characteristic policy has not changed over the past several years, the continuing downward and diminishing trend in organic resources is of great concern to the Air Force. (This subject is more thoroughly discussed in Chapter IX of this monograph.)

(3) As of 1 January 1965, the Air Force had nine AMAs, four of which were deactivated during the Vietnam era. This deactivation entailed massive transfers of workloads, equipment, and personnel to the remaining five AMAs. Only 22 percent of the trained work force functionally transferred which required an extensive recruiting and training program to replace the 8,000 trained personnel lost to the maintenance work force.[31] In addition, the Air Force was forced to increase the use of overtime in support of high priority depot maintenance requirements to an unprecedented level. During FY 68 the depot maintenance facilities expended 2.8 million hours of overtime at a cost of over $14 million to meet the emergency and urgent demands of the operational commands for depot and field team support. In FY 65, the AFLC on-board strength was 124,000 direct hire civilian personnel. In FY 66, on-board strength rose to a high of 132,000 civilians, largely due to the Southeast Asia buildup. By the end of FY 67, the on-board strength had declined to 127,000. In FY 68, the impact of the war on the Air Force structure was being strongly felt by AFLC, beginning with an underfunding of the manpower program of almost 2,500 man-years. This was followed by a reduction of an additional 1,000 man-years in the third quarter and the accompanying loss of 3,000 authorizations in the fourth quarter.[32] A further reduction of 3,400 Air Force civilian personnel occurred between FY 69 and FY 70.[33]

(4) The Air Force has been able to support Southeast Asia, but at the expense of deferred maintenance, as mentioned earlier, and with a gradual increase of workload going to contract. The civilian personnel reduction problem is compounded by the "last in, first out" concept which tends to force young people out and retain the older employees. The consequences of this practice on the Air Force civilian maintenance work force[34] are shown as follows:

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[30] U.S. Air Force Logistics Command, Letter, subject: Revenue and Expenditure Control Act of 1968, 11 October 1968.

[31] U.S. Air Force Logistics Command, Posture Analysis Report, 1 July 1969, Vol. IV, p. 6-2.

[32] U.S. Air Force Logistics Command, Letter, subject: Revenue and Expenditure Control Act of 1968, attachment, 11 October 1968.

[33] U.S. Congress, House of Representatives, Hearings, subject: Department of Defense Appropriations for 1970, Subcommittee of the Committee on Appropriations, 91st Congress, 1st Session, Department of the Air Force, Part 7 1969, p. 59.

[34] Office of the Secretary of Defense (Installations and Logistics), Report of the Long Range Policy Board, February 1969, p. 55.

Age Level	White Collar Workers	Blue Collar Workers
Under 30	1.4%	12.4%
30 to 44	40.7%	35.3%
45 and above	57.9%	51.3%
55 and above	10.5%	15.5%

(5) The length of service of the civilian work force is also high and, when combined with the age of this force, will produce a "retirement hump" beginning in 1971-72. The loss of older employees will require the advancement of many younger employees for whom there are inadequate replacements available. Past reductions have resulted in the separation or downgrading of recent college graduate hires. The following statistics portray the educational profile of the Air Force logistics work force and illustrate the need for young talent with educational backgrounds:

Work Force	Less Than High School	High School	BS/BA Degree	Advanced
Civilian	8%	75%	15%	2%
Military	0%	23%	69%	8%

4. STRENGTHS, WEAKNESSES, AND LESSONS LEARNED

a. General. The basic Air Force logistics concept requiring forces in-being which operate under the same policies and procedures in both peacetime and war permitted a prompt response and an orderly buildup of forces in the initial phase of the Vietnam conflict. Deployment of forces under routine mobility procedures with follow-on support provided from the Air Force Logistics Command and offshore bases enabled construction of in-country support facilities for the long-term combat situation with no disruption in combat capability or degradation of weapon system readiness.

b. Base Self-Sufficiency. Despite the commendable support provided the Air Force combat forces in Vietnam, the maximum base self-sufficiency concept imposed the requirement for transferring skills and equipment from CONUS, and for extensive maintenance facility construction in Vietnam. These activities produced further requirements for support personnel and facilities to provide for the needs of these maintenance people and their technical activities. As a result of this extensive buildup in Vietnam, the question arose as to whether the same caliber of support could be provided to combat forces by performing more maintenance in CONUS and thus reducing personnel, equipment, and logistic facility requirements in-country. Project PACER SORT was designed to test this concept. Useful data was gathered by PACER SORT; however, the results were inconclusive. This effort indicated that changing basic concepts to simplify logistics problems is not practical in time of war. While the most propitious time to develop the support concept of a weapon system is early in its design so that the proper influence may be exerted on decisions regarding repair levels, there is still the possibility of changing in-being weapon systems on an item-by-item basis. AFR 66-1, revised 10 January 1969, rescinded the maximum base maintenance self-sufficiency concept and established an optimum repair concept. Because of the tremendous potential in this area, the Air Force should continue in its efforts to reduce overseas maintenance requirements. Strides made in peacetime extend to combat environments.

c. Depot Level Support

(1) The Air Force single point depot support concept proved successful. The collection and segregation of maintenance data furnished these depots with an abundance of usable information which, when combined with supply and transportation data, enabled system and item

managers to make sound decisions concerning current operations and future planning. Depot area assistance teams provided help in Southeast Asia when and where needed. The personnel comprising these Rapid Area Maintenance (RAM) teams had developed skills from extensive experience in performing depot level maintenance on the same weapon systems needing repair in Vietnam. This experience contributed materially to the success of the program. The need for some military to provide depot level area support was recognized by the formation of Combat Logistic Support Squadrons.

(2) The Air Force Materiel Areas readjusted their workloads consistent with the increased requirements resulting from Southeast Asia activities. More organic depot maintenance capabilities for vital weapon systems were made available by placing less vital workloads on contract or by deferring some maintenance.

(3) The requirement for a qualified organic capability and a stable work force was highlighted by materiel failures which occurred during the Vietnam conflict and which occasionally resulted in immediate or imminent grounding of large numbers of aircraft. The resolution of these problems depended on the immediate availability of qualified engineers to develop a fix, adequate facilities in which to perform the work, and skilled technicians experienced in the type aircraft involved and capable of accomplishing the repair.

d. Reparables

(1) Experience in Vietnam pointed out the need for better visibility and control of reparable assets. This was obtained by implementation of the Due in From Maintenance (DIFM), the Management of Items Subject to Repair (MISTR), and the Air Force Recoverable Assembly Management System (AFRAMS) programs. Gaining control of reparables opened up new possibilities of providing more responsive and less costly support through changes in maintenance concepts, such as qualifying the concept of maximum base self-sufficiency on a weapon system or item basis.

(2) Responsive support of reparables from CONUS repair facilities was imperative as the first step in convincing commanders that they could relinquish possession and local repair capabilities of critical components without detriment to their operational capability. The concept attempted by Project PACER SORT maintained that equally responsive support at less overall logistics cost can be achieved by repairing selected items and components in CONUS facilities in lieu of in-theater. The responsiveness of airlift was proven during the Vietnam era when receipt of NORS items averaged 5 days.

e. Performance. Since maintenance concepts dictate supply and transportation policies, it is essential that all three areas operate as an integral system. In Vietnam, the entire logistic system, including maintenance, functioned well. Air Force units in Southeast Asia flew two to three times their normal flying hour program with the lowest Not Operationally Ready—Supply (NORS) rates in Air Force history. Despite the necessary emphasis on Southeast Asia, Air Force units worldwide also maintained the highest levels of operational readiness. Maintenance support was described as outstanding in most instances.

f. Mobility

(1) The mobility concepts of "going to war with what you have" have been extensively tested and practiced, and have been employed in other emergencies prior to Vietnam. These experiences, combined with the Air Force-wide standard maintenance organization prescribed by Air Force Manual 66-1, permitted the expeditious and easy transition of fighter, bomber, and transport units to Southeast Asia. The Tactical Air Command, in cooperation with the Air Force Logistics Command and the Air Force Systems Command, is developing portable, lightweight reusable equipment and facilities as demonstrated in Project CORONET BARE. The results of this project should further enhance Air Force deployment capabilities in the future.

(2) The forward operating base concept proved to be the only feasible method of operating on austere bases in a combat environment. It became necessary to convert forward

operating bases to main operating bases to keep pace with sustained, high tempo operations especially under the maximum base self-sufficiency concept.

g. Vehicles and Materials Handling Equipment

(1) The Air Force vehicle support concept was not realistic in time of war and resulted in the inability to maintain satisfactory numbers of operational vehicles and materials handling equipment early in the Vietnam era. Air Force policies and practices regarding commercialization of the vehicle fleet, procurement and distribution of a variety of makes and models, off-the-shelf supply support, contract depot level maintenance, service-station and base level maintenance, and unrealistic utilization rates all contributed to the lack of support provided in this area. With today's dependence on speed and efficiency, the motor vehicle on an air base is a necessity if work is to be done and missions are to be accomplished within established time standards. Expedited delivery of personnel, equipment, supplies, and information are wholly dependent on responsivie on-base transportation. Vehicles deadlined for parts or maintenance cannot contribute to mission success. Vietnam experience dictates that the provisioning process must be applied to commercial vehicles in the same manner as applied to other military equipment (see Supply Management Monograph) and vehicle support must be established consistent with mobility and MOB/FOB concepts of operation.

(2) The need for a controlled replacement and/or overhaul program for aerospace ground equipment (AGE) was recognized by the publication of Air Force Regulation 66-31, Uniform Repair/Replacement Criteria For Air Force Aerospace Ground Equipment (AGE), 2 June 1969.

h. Personnel. Maintenance manning supported both organizational and intermediate units in Southeast Asia even though the level of activity was considerably larger than that which existed when manpower needs were initially determined. The additional availability of personnel and the extension of work days beyond the normal eight hours per day, seven days per week, combined with the motivation to perform the job well, compensated for the increase in maintenance workload. Therefore, few adjustments were required in maintenance manning levels for combat support units during the Vietnam era.

i. Deferred Maintenance. To keep pace with increased requirements imposed by the Vietnam conflict, the service life of older aircraft and equipment was extended. This practice resulted in an acceleration of fatigue failures and wear-out rates. Correction of these failures consumed a significant quantity of unprogrammed maintenance man-hours and funds. To make up this deficit, certain programmed maintenance was deferred with degrading effects on overall Air Force capabilities. At the conclusion of activities in Southeast Asia, a refurbishing of equipment will be necessary and will add to the maintenance workload already deferred. The likelihood of this occurrence in a future contingency should be recognized and the resultant increases in requirements for maintenance resources should be provided for early enough to prevent an accumulation of deferred maintenance beyond that judged to be an acceptable limit.

5. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) The basic Air Force logistics structure supporting forces in-being, which operate under the same policies and procedures in peacetime and war, permitted initial response and buildup of forces in Southeast Asia in a prompt and orderly manner (paragraphs 1a(1), 1b, 2d, and 4a).

(2) The Air Force concept of utilizing forward operating bases during the initial stages of a contingency with remove-and-replace maintenance procedures worked well. The nonexistence of adequate facilities and the combat environment indicated that this was the only feasible concept in the early stages of conflict (paragraphs 2a(a), 2d, 4a, and 4f).

(3) In the sustained, high tempo operation, it became necessary to convert forward operating bases to main operating bases (paragraphs 2a(1) and (2), 2d, and 4a).

(4) The maximum base self-sufficiency policy in existence during the buildup in Vietnam carried over from CONUS bases to those in Southeast Asia and dictated an undesirable sophistication that required the same type of equipment, facilities, skills, and extensive supply support in-theater as existed in CONUS (paragraphs 1b, 1d(1) and (2), 2d, and 4b).

(5) The efforts of the Air Force to modify the maximum base self-sufficiency concept on existing weapon systems (Project PACER SORT was directed by USAF Test Order 66-27, 11 January 1967) were inconclusive and indicated that it is not practical to change basic support concepts affecting weapon systems in a combat environment. The Air Force recognized, however, the potential gain of improving repair level decisions by revising its basic policy in January 1969 from that of maximum base self-sufficiency to one of optimum repair (paragraphs 2a(2), 2d, and 4b).

(6) The Air Force depot maintenance organizations provided responsive support during the Vietnam era. Air Materiel Areas adjusted their workloads consistent with the increased requirements of Southeast Asia. Workloads beyond organic capabilities were either placed on contract or deferred, depending on priority (paragraphs 1a(1), 2a(3), 2g, 3c, and 4c).

(7) The Rapid Area Maintenance Teams provided necessary depot level support to combat activities in Southeast Asia, particularly for crash and battle damaged aircraft. The success of this program was largely due to the skills possessed by these teams which had been developed in CONUS depots on the same weapon systems needing repair in Southeast Asia (paragraphs 2a(1), 2g, 3c, and 4c).

(8) Close and continuous control of reparable assets was found necessary by the Vietnam experience. Three applications of existing automatic data processing systems were the basis for this control:

(a) The Due in From Maintenance (DIFM) program provided base maintenance and supply managers and CONUS inventory control points (ICPs) with visibility of reparable assets at base level as measured by time standards for repair, status of repair parts, return of reparables to CONUS and other factors.

(b) The Air Force Recoverable Assembly Management System (AFRAMS) began operating on 1 November 1967 and provided daily visibility to inventory control points (ICPs) in CONUS on authorized levels of assets by condition and location. Assets now covered are some 163,000 line items with worldwide value exceeding $6 billion.

(c) The Management of Items Subject to Repair (MISTR) program was implemented in July 1965 and provided to depot maintenance a biweekly projection, by priority, of those items requiring repair to satisfy supply demands (paragraphs 1d(2), 2b, and 4d).

(9) The use of airlift, especially for high priority and high cost items, proved essential to the overall reparable program (paragraphs 1a(1), 2e, and 4d).

(10) The integration of logistics management involving base level and depot level supply and maintenance functions, and including effective use of transportation, provided responsive support to Southeast Asia during the Vietnam era. Air Force units in Southeast Asia flew two to three times their normal flying hour program with Not Operationally Ready—Supply (NORS) rates lower than ever before in the history of the Air Force. Air Force units worldwide were kept at the highest level of operational readiness in Air Force history (paragraphs 1a(1), 2a(3), 2d, 2e, and 4e).

(11) Tried and tested mobility concepts combined with standard maintenance organizations permitted rapid deployment and employment of Air Force combat units in Southeast Asia. Under Project CORONET BARE the Air Force is taking steps to enhance the rapid

response capability of Air Force units through design of lightweight equipment and relocatable, reusable, modular constructed facilities (paragraphs 1a(1), 2a(1) and (2), and 4f).

(12) The Air Force vehicle support concept was not realistic for operation in underdeveloped areas and resulted in the inability to maintain satisfactory numbers of operational vehicles and materials handling equipment in Southeast Asia. Supply and maintenance procedures for commercial vehicles were not geared to keep pace with rapid deployment and operational capabilities of tactical units (paragraphs 2a(1) and (2), and 4g).

(13) The increase in activities during the Vietnam era without a concomitant increase in funds resulted in postponing some programmed maintenance to a deferred category. The Air Force has expressed concern over the accumulation of deferred maintenance and its future impact on overall Air Force capabilities (paragraph 3c). (See also Chapter VII and IX.)

b. Recommendations. The Board recommends that:

(MT-7) The Services, in order to maintain operational effectiveness but reduce to the maximum extent possible the requirement for personnel skills, equipment, facilities, and supplies in forward operating locations and bases, review on an item-by-item basis their decisions on where and at what level an item should be repaired (conclusions (4), (5), (8), (9) and (10)).

(MT-8) The Air Force use future mobility service tests such as CORONET BARE to explore the feasibility of reducing forward area maintenance requirements (conclusion (11)).

(MT-9) The Air Force reexamine its support policies and procedures for vehicles and materials handling equipment in order to ensure support incident to deployment and increased operations (conclusion (11)).

CHAPTER VII
DEFERRED MAINTENANCE

1. INTRODUCTION

a. The review of deferred maintenance examined the impact on responsiveness to Southeast Asia and other theaters of operation. Included in the review was the current scope of deferred maintenance in the Services, the constraints which prevent accomplishment, and the Services planning for return and rehabilitation of equipment from Vietnam. Deferred maintenance was defined as planned maintenance workload which was not accomplished due to a resource or other constraint. Reparable items excess to current requirements, maintenance required to activate reserve fleet ships, and equipment held in contingency reserve are not considered as deferred maintenance.

b. The Services, even with extensive and supplemental resources being applied to maintenance during the Vietnam era, were still unable to keep up with requirements. Extension of inspection and overhaul intervals, operation of aging obsolescent equipment, continuation in service of equipment beyond its programmed life cycle, increased usage, and the effects of Southeast Asia climate all contributed to increasing the maintenance workload. The absence of adequate spares in the overall systems resulted in repairing some items not intended for repair and in locally manufacturing other items which would otherwise have been unavailable. This overall increased workload beyond capability to produce led to selective scheduling and deferrals to meet immediate operational needs. The inability to precisely predict the impact and cost of these maintenance deferrals prevented supportable reclama for full resource support; nevertheless, all the Services believe that the magnitude of the deferred maintenance backlog is excessive and have voiced concern over its projected escalation.

c. Each Service's maintenance program permitted work to move to the next higher maintenance level so that deferrals were in some degree measurable at the depot level. The difficulties experienced by the Services in providing data for this review attested to the lack of adequate maintenance information programs to enable managers to forecast and assess the impact of deferred maintenance in terms of operational capability. It must be assumed that this same lack of data inhibits the Services' ability to determine the best option when selecting which maintenance workload to defer and precludes adequate planning for restoration. The Services' positions regarding deferred maintenance are contained in paragraphs 2 through 5 of this chapter.

2. ARMY

a. General

(1) Army deferred maintenance had no serious impact on the buildup or support of Army forces in Southeast Asia. The mission of SE Asia forces carried with it a priority of sufficient urgency to ensure satisfaction of all major requirements, often to the detriment of other Army commands. The requirement to retain equipment in operation beyond prescribed overhaul intervals because of a lack of repair cycle float, and the diversion of in-theater general support capacity to direct support created a sizeable unmeasureable workload of deferred maintenance within the theater. Redeployment of units and equipment from SE Asia will create a potentially greater backlog of deferred maintenance unless financial restraints are relaxed.

(2) Deferred maintenance affected a significant inventory of end items and secondary items for known requirements. Those items for which a firm Army requirement exists are identified in this chapter as net capability. Existence of assets retained for possible future use was recognized, but generated no requirement for funds or other resources at this time.

(3) The Army established semiannual reviews by the Depot Maintenance Requirements Board of the total worldwide depot maintenance program. The Board considers recommended programs, as presented by the commodity managers, and establishes that program which represents the best combination in terms of assets, capability, funds, and repair parts to support overall Army requirements. The approved program, identified as net capability, forms the basis for appropriations requests. The difference between net capability and funded programs represents deferred maintenance.

b. The magnitude of the FY 70 deferred maintenance backlog varied by commodity, as shown in Table 40.

TABLE 40

MAINTENANCE BACKLOG BY COMMODITY
($ Thousands)

Commodity	Net Capability	Funded Program	Deferred (Unfunded)
Aircraft	397,271	285,540	110,731
Automotive	87,268	46,133	41,135
Combat Vehicles	122,313	93,871	28,442
Elec/Commd.	50,305	34,198	16,107
Armament	38,244	22[illegible]6	15,698
Ships	23,869	11,247	12,622
Construction	21,025	14,143	6,882
Missiles	57,909	53,314	4,595
General Equip.	26,140	21,739	4,401
Rail	3,289	1,687	1,602
Commodity Groups	18,073	16,952	1,121
Total	845,706	602,370	243,336

Source: Department of the Army, Deputy Chief of Staff for Logistics, Memorandum, subject: Gross and Net Funded and Unfunded Requirements, FY 70, 12 January 1970.

c. Constraints which contributed to the known deferred maintenance backlog fell into two categories: lack of adequate maintenance floats and insufficient overhaul/rebuild funding.

(1) Operational readiness of Army forces overseas and in the continental United States (CONUS) require a continuing program for the overhaul of aging equipment and its replacement with serviceable equipment. To effect such a program and simultaneously maintain prescribed readiness rates, a repair cycle float of items subject to overhaul is necessary. The Department of the Army established the requirement for repair cycle float to facilitate a one-for-one exchange of selected items when depot maintenance was prescribed. This caused a reevaluation of the total maintenance float concept and preparation of a draft regulation incorporating a repair cycle float as a matter of Army policy. Repair cycle float was added to the Army authorized acquisition objective for aircraft for the FY 69 apportionment and the FY 70 budget cycle, but was denied by the Secretary of Defense in September, 1968. The OSD denial of repair cycle float was based on the fact that maintenance float requirement approved in prior years had,

in OSD opinion, included both intermediate (operational readiness) and depot (repair cycle) float. While it was recognized that a valid need for increased quantities might exist, OSD directed that repair cycle float quantities be deleted until item-by-item increases were justified. Because of current fund availability no funds have been appropriated for repair cycle float acquisition.

(2) Accelerated usage rates, increased in-use densities, increased age, and damages inherent in battle in SE Asia caused annual overall requirements to expand at a rate far above that experienced prior to 1965. Although the level of funding for Army overhaul programs increased threefold from FY 65 to FY 69 it remained far below that required for support of requirements. A measure of the inadequacy of these levels was reflected by significant increases in overhaul costs caused by spiraling labor and materiels costs, as shown below:[1]

Item	FY 65	FY 69
M60A1 Tank	$20,585	$35,385
M48A3 Tank	20,336	35,481
M88 Recovery Vehicle	18,988	40,584
M42A, SP 40mm Gun	14,500	29,487

(3) Concurrent with these increases other costs associated with maintaining worldwide forces grew to such proportions that apportionment of available funds to overhaul, procurement, transportation, and the other essential functions were not adequate to accomplish total requirements. With each fiscal year the problem was compounded with increasingly more low priority work deferred in order to support SE Asia forces. With redeployment from SE Asia and the attendant reduction in Army forces the amount of equipment requiring maintenance, and funds, was expected to reach an all time peak in the FY 71-72 time frame of nearly $1 billion annually.

3. NAVY

a. Ships and Craft

(1) Maintenance funding had amounted to less than total requirements prior to the SE Asia conflict which resulted in a bow wave of deferred maintenance when the buildup commenced. Because of austere funding in FY 61 through FY 65, repairs of major items such as destroyer main feed pumps, main condensate pumps, boiler uptakes, electrical cable renewals, and piping renewals were frequently deferred.[2] In FY 64, the interim ship overhaul program was terminated without any reduction in the overhaul cycle time.

(2) During the Vietnam era, the built-in backlog of deferred maintenance, the advancing age of many ships of the fleet, and the increased tempo of operations adversely combined to escalate shipboard maintenance requirements. Available resources were assigned in priority to the most urgent tasks. Fleet Ballistic Missile forces were fully supported and units deployed to the Western Pacific (WESTPAC) and the Mediterranean were provided resource and manpower priorities at expense of nondeployed units. The responsibility of accomplishing unfunded industrial requirements fell upon forces afloat and consequently, with limited afloat maintenance capacity, much maintenance could not be done. Statistics have shown that the increased shipboard maintenance workload unfavorably influenced enlisted retention rates in the areas which required the most attention such as boilers and machinery.[3]

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[1] Department of the Army, Deputy Chief of Staff for Logistics, Memorandum, subject: Deferred Maintenance, 1 December 1969.

[2] U.S. Navy Office of Chief of Naval Operations, Letter, subject: Logistics Posture at Start of Vietnam Build-up-Maintenance Support Ships, 26 June 1969.

[3] U.S. Congress, House of Representatives, Hearing, subject: Status of Naval Ships, Special Subcommittee on Sea Power of the Committee on Armed Services, 91st Congress, First Session, 28 January 1969, p. 284.

(3) This situation was further intensified by the failure to call up the Naval Reserve during the Vietnam conflict which resulted in a drain of experienced personnel from the fleet to annually fill the Navy's in-country billets. Equipment casualty rates and the number of non-scheduled repair availabilities increased significantly, requiring that sufficient funds be channeled to provide the industrial support necessary to enable the fleet to carry out its mission. In FY 66 an additional $63.3 million was necessary above the funds apportioned, which reflected a quantifiable amount of deferred maintenance from years prior to the buildup. Chapter IV, Navy Maintenance, describes the growth of fleet maintenance expenditures and ship equipment casualty rates during the Vietnam era. The following representative situations show the impact of deferred maintenance on fleet operations:

(a) The ammunition ship USS SHASTA (AE16) main engine overhaul was deferred in 1967-68 due to lack of material. The engines subsequently failed during deployment in 1968 and caused the ship to return to the United States early.

(b) Catwalk wireway repairs to the gasoline tanker USS NESPELEN (AOG55) were deferred in 1968 due to shortage of funds. Subsequently a fire was caused by deteriorated wiring insulation, and repair delayed the ship's deployment 6 weeks.

(4) Table 41 provides a summary of the number of ships overhauls which were deferred during the Vietnam era.[4] Studies have substantiated that higher restoration costs occur because of maintenance deferrals; however, insufficient data was available to quantify this for Navy ships during this period.

TABLE 41

SUMMARY OF NAVY SHIP OVERHAUL DEFERRALS, FY 64-69

FY	Overhauls Requested by Fleet CINCs	Accomplished	Deferred
64	399	239	160*
65	430	231	199
66	251	203	48
67	269	270	
68	260	232	28
69	283	194	89

*Interim overhaul program terminated.

(5) The magnitude of the backlog of deferred maintenance in the Reserve Fleet, and the extensive maintenance usually required after reactivation, brought about a reevaluation of mobilization planning. This requirement was emphasized by the lessons learned from the ship activations during the Vietnam era. Activation of the hospital ship USS REPOSE (AH 16) was an example in which great difficulty was experienced in bringing the ship to a reliable operating condition. Similar experiences occurred with 17 landing ship tanks (LST) where the activation periods varied from 8 to 12 months. After reactivation, these ships required continued industrial assistance which varied from 3 months to a year before the ships were self sufficient and combat capable.[5]

[4] U.S. Navy, Office of Chief of Naval Operations, Letter, subject, Logistics Posture at Start of Vietnam Build-up Maintenance Support, Ships 26 Jan 1969 and U.S. Navy Office of Chief of Naval Operations, Statistics on Ship Depot Level Maintenance Funding, 1 Oc 1969.

[5] U.S. Navy, Office of the Chief of Naval Operations, Memorandum, subject: Deferred Maintenance, 28 October 1969.

(6) Valid information on the actual condition of inactive ships, especially propulsion plants, piping and electrical systems, was not available. Lack of funds have precluded obtaining and maintaining this information in the past. Overhaul of inactive ships was terminated in FY 59 due to a lack of funds and personnel. In FY 70, the inactive Reserve Fleet maintenance funds and personnel ceilings were reduced $3 million below the minimum necessary to prevent further deterioration and emergency drydockings. Although exact cost data were not available, listed below is an estimate of funds required for accomplishing necessary repairs and minimum alterations for reactivation of inactive ships and craft in the Reserve Fleet. These estimates were developed from weighted averages of data compiled on 88 inactive ships during a study conducted by U.S. Naval Ships Systems Command in 1967-68. Data were based on the composition of the Reserve Fleet as of 1 January 1968.[6]

	Number	Needed Repairs	Minimum Alterations
Ships	757	$2,010,000,000	$1,380,900,000
Service Craft	204	72,000,000	

Activation cost variations between industrial activities range from factors of 0.70 to 1.32 and the above figures represent average costs which exclude routine activation and outfitting costs. Since 308 destroyers and destroyer escort vessels of World War II construction have propulsion plants which are not supportable, it is probable that one-fourth of this number would be required for cannibalization to support the remaining three-fourths.

b. Aircraft

(1) Naval aviation maintenance requirements for Southeast Asia were fully supported while other areas absorbed the maintenance deferrals. The projected workload for depot repair facilities was escalated when the configuration of combat type aircraft necessitated a change to operate successfully in the Vietnam environment. The increased complexity of aircraft and weapon systems also caused an increase in the man-hours required for each aircraft as shown in Figure 31. Major aircraft modifications included installation of electronic countermeasures equipment, structural modifications because of increased aircraft weight, increased engine power requirements, tanker conversions, and additional crew protection. Installation of these changes and the increased work due to complexity required more funds and the expenditure of man-hours which were not recognized in the budget. Therefore, beginning in FY 68, the depot maintenance program was seriously underfunded which resulted in aircraft being extended beyond the normal cycle for progressive aircraft rework,[7] as follows:

FY	Required Funds	Available Funds	Aircraft on Extension
68	$464,800,000	$402,800,000	898
69	723,900,000	671,200,000	779
70	738,800,000	670,300,000	1252

(2) During the period ending in FY 66, the Navy normally carried about 340 aircraft in a deferred depot level maintenance status, or aircraft operating beyond that time when they should have been inducted for rework. As a result of underfunding in FY 69, this number of aircraft grew to 779 with a projection of 1,252 deferrals in FY 70, an unacceptable quantity.

[6] U.S. Navy, Naval Ship Systems Command, Letters to Chief of Naval Operations, subject: Inactive Ship Cost Effectiveness Study, Ser 0373 of 23 October 1967, Ser 04 of 20 March 1968, and Ser 07 of 14 June 1968.
[7] Briefing to Joint Logistics Review Board by Naval Air Systems Command, U.S. Navy Aviation Maintenance (Depot), 29 April 1969, and Letter, Office of Chief of Naval Operations, Deferred Maintenance, 29 October 1969, enclosure 3.

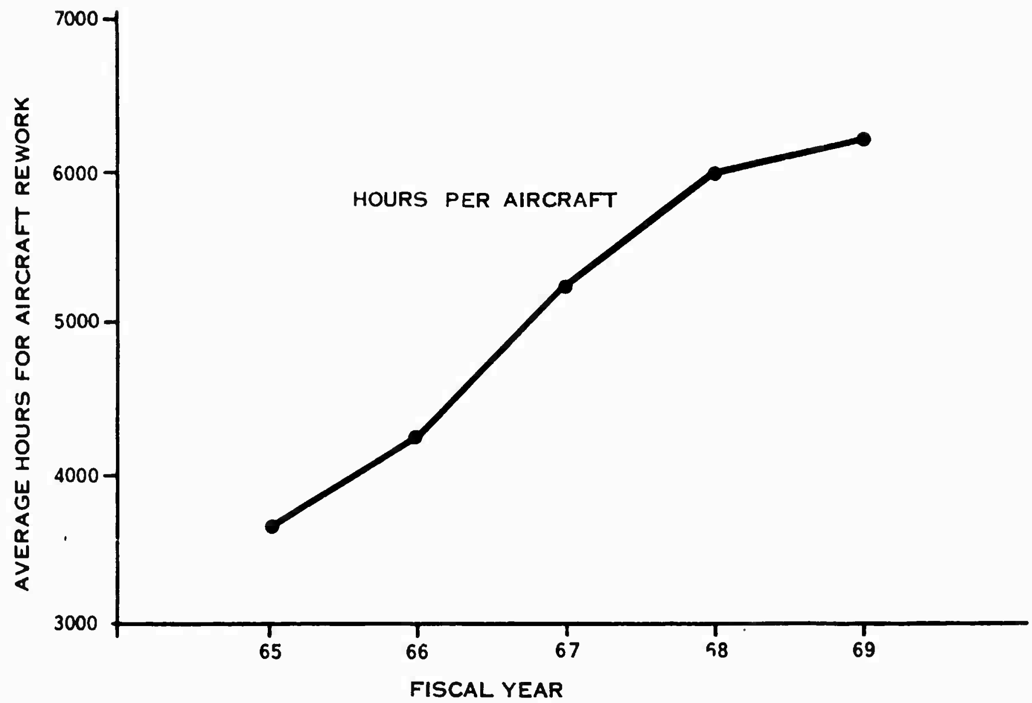

FIGURE 31. INCREASED COMPLEXITY OF AIRCRAFT REWORK

(3) A continuing study of the A-4 aircraft revealed that a 10 percent increase in depot maintenance man-hours can be expected for each month an aircraft is extended beyond the required rework or maintenance period. Analysis was made of a random sampling of several aircraft to compare the average maintenance man-hours expended when aircraft are extended beyond the naval progressive aircraft rework (PAR) schedule, as shown in Table 42.

TABLE 42

RESULTS OF AIRCRAFT BEING EXTENDED BEYOND PROGRESSIVE AIRCRAFT REWORK SCHEDULE

Aircraft	Average Man-Hours	Increase (%)
F-4B		
Normal PAR Schedule	11,067	
Extended 3 Months or More	13,845	+25.1
CH-46D		
18-Month Tour	4,246	
19-Month Tour	4,327	+1.9
20-Month Tour	4,478	+3.6
A-4C		
Normal PAR Schedule	4,303	
Extended 3 Months or More	4,661	+8.3
S-2D		
Normal PAR Schedule	3,866	
Extended 3 Months or More	4,509	+16.6

Source: U.S. Navy, Office of Chief of Naval Operations, Deferred Maintenance, 28 October 1968, Enclosure 3.

(4) The funding constraints related to the aircraft engine rework program caused engines to be inducted for repair in lieu of overhaul. This program, discussed in Chapter IV under the Complete Engine Repair program, kept engines in the supply pipeline to meet urgent SE Asia requirements. Repair in lieu of overhaul can be accomplished for less cost; however, engines were not extended beyond their maximum operating time and removal for high time was mandatory. Engines placed into an awaiting overhaul status were effectively lost assets until scheduled for overhaul. In FY 69 the aircraft engine rework program at the seven naval aircraft rework facilities had a backlog of 380 engines awaiting overhaul because of lack of funds.[8]

(5) Reduced production of later SIDEWINDER (AIM-9D/C) and SPARROW (AIM-7E-2) missiles compelled the repair of older SIDEWINDER (AIM-7B) configurations as replacements in areas other than SE Asia. Expiration of shelf life and degradation of the older SIDEWINDER components generated additional significant rework requirements for which funds were not available, or $56.1 million in deferred maintenance.[9]

(6) Table 43 is a summary of the Navy's known deferred maintenance backlog for FY 70 (as of 1 November 1969).

TABLE 43

SUMMARY OF FUNDS TO ELIMINATE FY 70 NAVY DEFERRED MAINTENANCE BACKLOG

Commodity	Dollars (Millions)
Aviation (Aircraft & Engines)	62.2
Missiles	56.1
Active Atlantic and Pacific Fleet Ships	36.0
Service Craft[1]	5.0
Electronics	7.0
Commercial Design Automotive, Construction, and Weight Handling Equipment	2.3
Construction Battalion Equipment[2]	4.3
Reparables[3]	123.4
Inactive Fleet Maintenance	3.0
Fleet Marine Force Expeditionary Equipment[4]	2.1
	301.4

Notes: (1) Service craft overhauls have been funded at 50 percent of requirements since FY 66 and FY 70 funding restraints have deferred almost all overhauls.

(2) Funds include repair/rehabilitation, transportation and preservation of $8.0 million in retrograde inventory investment from Vietnam for FY 70. (Letter, Commander Naval Facilities Engineering Command T-Day Planning, 6 October 1969.)

(3) Table 44 provides a dollar value breakdown by commodity and Navy Cognizance Symbol of total reparable repair costs and unfunded FY 70 requirements.

(4) Headquarters, Marine Corps, Memorandum to Joint Logistics Review Board, subject: Backlog of Essential Maintenance and Repair for FMF Expeditionary Equipment, 24 December 1969.

[8]U.S. Navy, Office of Chief of Naval Operations, Letter, subject: Deferred Maintenance, 28 October 1969, Enclosure 3.
[9]Ibid.

c. Reparables

(1) Procurement levels of new reparables established rates of repair of existing not-ready-for-issue (NRFI) units. Delay or deferral of repair without a commensurate increase in procurement levels resulted in major equipments being inoperative for extended periods of time, with a corresponding adverse effect on readiness. A prime example was NRFI ship propellers and shafts, which were not inducted for immediate repair and subsequent positioning at stock points solely due to shortage of funds. This in turn delayed return of ships to an operational status pending repair and/or shipment of propellers and shafts. Other examples of maintenance deferrals caused by NRFI reparables included minesweeper PACKARD and General Motors cylinder head kits, WRC-1 radio modules, SPS-30 radar antennas, SPN-6/43 radar antenna pedestals, and 5"/54 rapid fire gun mounts.

(2) Table 44 provides a summary of data obtained from all major Navy Inventory Managers (IMs) and Inventory Control Points (ICPs). The difference between the dollar values of not-ready-for-issue materiel and the unfunded FY 70 requirements reflect the repair cost of excesses to programmed requirements. The decision to repair was on an as-needed basis and control was decentralized and maintained at the IM/ICP level. Excesses to programmed requirements have in the past been generated by decisions to retain items for insurance. This was in accord with existing Navy inventory management policies provided that retention was economically advantageous.

TABLE 44

REPARABLE REPAIR COSTS AND UNFUNDED FY 70 REQUIREMENTS

Commodity	Navy Cognizance Symbol	Estimated Repair Costs for NRFI Reparables ($ Millions)	Unfunded FY 70 Requirements ($ Millions)
Ordnance Equipment	2A	34.4	2.50
Ordnance Repair Parts in Support of Major Aviation Equipment	4A	6.2	0.32
Ordnance Electronics Equipment*	4N	44.0	2.89
TERRIER, TARTAR, and Tank Missiles	8T	6.3	3.18
Major Shipboard Electronics	2F	17.5	3.86
Major Electronics Equipment (NAVSHIPS)*	2N	9.7	2.65
Shipboard Electronics Equipment	2Z	2.5	0.52
Major Electronics Equipment (NAVELEX)*	4G	1.3	1.17
Hull, Electrical, and Mechanical Equipment	2H	12.8	4.88
Major Hull, Electrical, and Mechanical Equipment	2S	25.4	10.55
Training Devices	2O	0.09	0.09
Support of Training Devices*	8N	0.23	0.16
Aviation†	2R/8R	90.6	90.6
		251.02	123.37

*Also restrained by turnaround time and lack of repair parts.
†Also restrained by lack of repair parts and both organic and contractor capability.

(3) Extending the progressive aircraft rework cycle for an aircraft creates a two-fold detriment to the system by increasing the work content and generating a backlog for scheduling. A delicate balance exists between the length of the progressive aircraft rework cycle, the inspections conducted at the organizational level, safety of flight considerations and the man-hours available at naval aircraft rework facilities to accomplish the scheduled rework. The Navy has made substantial cost reductions by extending the repair cycle to the maximum extent possible commensurate with flight safety, recognizing the increased maintenance requirements depicted in the table.

d. Commercial Vehicles

(1) The maintenance standards for commercial design automotive vehicles and equipment were based on minimizing life cycle costs. DOD Instruction 4150.4 established the life expectancies of commercial vehicles. Based on the established life expectancies, the Navy programmed only sufficient maintenance funding to provide safe and efficient operation during their normal life cycle. Overhauls were thus eliminated and recapitalization through maintenance avoided. The concept of commercial vehicle maintenance and replacement did not contemplate a deferred maintenance backlog. In effect, however, deferred maintenance was represented within the backlog of vehicles and equipment eligible for replacement. At the end of the normal life cycle, this situation presented the program manager with the decision whether to authorize uneconomical rehabilitation and recapitalization through maintenance channels or to operate without the piece of equipment. This was contrary to the intent of DOD Instruction 4150.4.

(2) In 1969, the Navy had an inventory of $43.7 million in vehicles and equipment which had reached the end of their economic life cycle as defined in DOD Instruction 4150.4. Lack of funds precluded the procurement of replacements. In FY 70, a total of $2.3 million was budgeted to provide essential maintenance for these vehicles and equipment. At the present procurement funding levels, deferred maintenance will accelerate at the rate of 7 percent annually (one of each three vehicles requiring replacement will be replaced).

4. MARINE CORPS

a. General. At the start of the Vietnam era, with few exceptions, there were sufficient quantities of major end items of equipment to meet all known Marine Corps materiel requirements. Deferred maintenance did not have any particular impact on major end items pertaining to responsiveness to the SE Asia buildup. The FY 70 deferred maintenance for major end items and secondary depot reparables in the Marine Corps was $14.1 million. This deferral was considered as a programmed deferral and reflected maintenance at the depot level only. These items will be considered for repair along with the planned FY 71 maintenance requirement. Should constraints be placed upon the FY 71 maintenance requirement, then the decision for inclusion in the maintenance schedule will be made on an item-by-item basis.

b. Depot Maintenance Program

(1) The Marine Corps identified the backlog of deferred depot maintenance of $12.9 million for major end items as part of the total Marine Corps depot maintenance requirement.[10] When financial constraints were imposed by OSD, decisions as to what should be repaired within the Marine Corps were made on an item-by-item basis, with emphasis on support of the Fleet Marine Forces.

(2) The Marine Corps Automated Readiness Evaluation System (MARES) provided the data on equipment readiness which was used in the decision making process on the priority of repair and determination of deferments.

(3) When requirements for ground equipment major end items were determined, all depot unserviceable assets were included as being applicable to the total requirement. When

[10] Headquarters, Marine Corps, Memorandum, subject: Deferred Maintenance, 15 October 1969.

repair/rebuild has been deferred a directly proportionate share of reduction of readiness was assumed throughout the Marine Corps.

(4) The Marine Corps policy on priority of work was to satisfy requirements of Fleet Marine Forces committed to Vietnam and the Special Landing Forces followed by the noncommitted Fleet Marine Forces. Requirements for combat support units, the Organized Marine Corps Reserve, and War Reserve stocks received a proportionately lower degree of satisfaction. As this progression continued, the capability to sustain combat operations in the event of full mobilization diminished, particularly in the case of Reserve forces.

(5) As of 15 October 1969, the Marine Corps had a total deficit in their secondary depot reparable program of $1.2 million. The acquisition value of these items, determined by a representative sampling of their current line item mix, is $3.7 million.[11]

5. AIR FORCE

a. The $285 million backlog of deferred maintenance reported in October 1968[12] increased to $363.64 million by August 1969.[13] It is for this reason that the Air Force has viewed its increasing deferred maintenance with concern. Further deferrals are anticipated as impending budget and manpower reductions occur along with the return from SE Asia of equipment needing rejuvenation. Constraints of manpower and funds over the past few years, without a concomitant reduction in mission requirements, have resulted in an escalation of deferred maintenance. The primary devices used to defer maintenance were intended to:

(1) Extend or defer Inspect and Repair as Necessary (IRAN) time cycles.

(2) Extend engine operating times beyond the accepted and published limits.

(3) Reduce or eliminate depot stocks.

(4) Reduce repair cycle pipeline spares.

(5) Reduce base stock levels.

(6) Reduce war reserve and mobilization assets.

While these actions alleviated the immediate problem they often proved very costly when the Air Force was required to resort to emergency programs to remedy defects generated by postponement of preventive maintenance.

b. The Air Force Logistics Command (AFLC) provides depot level maintenance support to the major operational commands. Depot maintenance requirements in support of the major commands are funded on a priority and precedence basis which causes the bulk of reductions to be in the mission support and non-SE Asia operations where the consequences of the shortages are not readily apparent. Although impacts on the primary operational missions of using commands have not surfaced as a result of the reductions in depot maintenance support, potentially serious consequences in the support forces are beginning to appear.

c. The depot maintenance workload requirement is related principally to the size and composition of the force structure, with related support equipment, and the rate at which force is used. The capability and capacity to perform the required depot maintenance workload, whether by the organic depots or in contractor facilities, are constrained by the size of the Air Force Operation and Maintenance (O&M) budget or by manpower ceilings. Work in excess of the capacity of the AFLC maintenance work force is contracted if funds are available. If funds are not

[11] Ibid.
[12] Air Force Logistics Command, Letter, subject: Revenue and Expenditure Control Act of 1968, 11 October 1968.
[13] Air Force Logistics Command, Letter, subject: Deferred Maintenance, 13 November 1969.

available, maintenance judged essential for continued economical operation of Air Force equipment is deferred and permitted to accumulate.

d. A massive diversion of capability and dollars has been expended to support the SE Asia effort on a priority basis. Utilization rates in SE Asia have generated large overhaul requirements for engines and exchangeables. Crash and battle damage repairs have used both organic and contract resources. Problems due to fatigue and corrosion in SE Asia have been of large magnitude, and modification of SE Asia aircraft to increase their capability or to convert them to a new mission have been a major user of capability. All these factors served to increase depot level maintenance workloads and, of themselves, would have caused some maintenance to be deferred. The sum of these increased workloads in the face of a decreasing trend in depot level personnel strengths and organic capacities combine to preclude orderly programming that would reduce the deferred deficits.

e. For several years budgetary and manpower constraints in the Air Force O&M appropriations have not permitted the funding of depot maintenance requirements as presented in the justification of appropriation request—often by significant amounts. In FY 69 the depot maintenance requirement was $1.516 billion with $1.231 billion available to apply to this requirement, leaving a deficit of $285 million.

f. A large percentage of the Air Force aircraft inventory is comprised of old aircraft. With utilization rates far higher than ever before and retention of aircraft longer than their designed life, many serious structural fatigue problems have been experienced which resulted in extensive, often unprogrammed, corrective actions. Examples are: the center wing replacement on C-130B/E aircraft, replacement of spar caps and wing panels on C-124's selected for retention, center section and lower wing outer panel replacement on the F-100, replacement of wing spars and wing fold fittings on A-1's, rear bulkhead modifications on all versions of the C-135, repair of wings of A/T-37's, and completion of the longeron and side skin modification on the long-life B-52G/H.

g. The administrative and support fleet in general has deteriorated to a marginal level. Corrosion and fatigue-induced failures accelerate rapidly and any delay in their discovery and correction increases the risk of in-flight failure. Much of this deterioration is located in inaccessible areas of the aircraft structure which requires disassembly beyond the capability of field organizations to accomplish. Continued deferral of depot maintenance on these aircraft, although not precisely predictable, may result in catastrophic failure at some point in the future and will then require the use of large quantities of unprogrammed resources to correct.

h. While the status of deferred maintenance on aircraft continues to be substantial, the trend in aircraft engines is showing improvement. Base level stocks of jet engines are computed by using various factors, such as overhaul and removal intervals, field maintenance removal intervals, flying hours, and automatic resupply times. While these levels vary by engine and engine type, a general rule would allow each base approximately 18 days worth of spare engines plus their war readiness materiel (WRM) requirements.

i. A sampling of jet engines portrays the support picture at base level where only 83.7 percent of those engines authorized on base were on hand in June 1967 (Table 45). This situation has improved to a stock position of 95.9 percent on hand as of January 1970 (includes both serviceable and reparable engines). During the same period when base stockage objectives were not being met, the depot stocks were reduced to zero. As of 4 November 1969, depot stocks on some engines (excluding reparables) were back up to 100 percent of computed requirement (Table 46).

TABLE 45

BASE LEVEL STOCKS (JET ENGINES)

(Aircraft) Engines	Dec 65		Jul 66		Jun 67		Jun 68		Jan 70	
	Auth	O/H	Auth	O/H	Auth	O/H	Auth	O/H	Auth	O/H
(F-100) J57-21	382	339	361	342	296	241	271	269	202	184
(F-102) J57-23	147	147	165	122	132	101	96	100	77	75
B52 J47-43	267	228	276	242	232	208	234	223	187	182
(F-106) J75-17	71	64	71	71	66	61	71	51	55	55
J75-19W	143	124	138	108	102	84	87	70	64	65
Total	1,010	912	1,002	885	828	695	759	713	585	561
(%)	(90.3)		(88.3)		(83.7)		(93.9)		(95.9)	

TABLE 46

ASSET SUMMARY OF UNINSTALLED J57 JET ENGINES

Engines	Aircraft	Base Stocks (%)	Depot Stocks (5)	Base Get Well Date
J57-13/53	F-101	100	100	-
J57-19/29	B-52	100	100	-
J57-21	F-100	82	0	Jan 1970
J57-23	F-102	100	100	-
J57-37	B-57	100	0	-
J57-43	B-52	100	37	-
J57-55	F-101	100	100	-
J57-59	C/KC-135	90	0	1 Feb 1970

j. The inability to provide depot level repairs or remanufacture of vehicles for all major Air Force commands has caused the out-of-commission rate to exceed acceptable standards. Vehicle overall condition has regressed to a point wherein reliability is questionable. Refurbishment of these vehicles to a condition compatible with that achieved by depot repair is beyond base capability. In view of the age and condition of Air Force vehicles with few, if any, replacements foreseen due to austere buy programs, increased reliance on depot repair is the only alternative. Deferral of depot repairs for these vehicles will cause the unreliability factor to steadily increase. Mission support could be jeopardized.

k. Since depot level repair and overhaul of vehicles is accomplished almost entirely by contractors, the only cause for deferral is lack of sufficient funds. Each major air command resubmits deferred vehicles as requirements for the next fiscal year. As of 15 August 1969 the deficit to repair those needed reparable assets in storage in Air Force supply depots and centers was computed at $232,997,000 for FY 70. It is Air Force policy to repair only those items for which valid requirements exist. For example, those assets which are reflected as potential DOD excesses, contingency reserves, or economic retention quantities are not normally repaired until a demand is identified. The determination of which items to repair is based on demand and is accomplished through the Management of Items Subject to Repair (MISTR) program outlined in Air Force Logistics Command Report 300-20.

6. SUMMARY

a. Throughout the Southeast Asia buildup, assignment of available Service maintenance resources was in consonance with the priority of the mission of the units. The deployed forces were normally fully supported, often at the expense of nondeployed units. Deferred maintenance did not visibly decrease the ability of the Service to meet major commitments. It did affect the total inventory of major end items and secondary items required for planned programs as to serviceability, with aircraft and ships being the primary commodities involved.

b. Funding limitations and lack of maintenance floats were judged the most singular causes of deferred maintenance; however, other constraints such as lack of an organic capacity and nonavailability of reparables, repair parts, equipment, and time also prevented the accomplishment of Service maintenance.

c. Visibility on the scope of deferred maintenance and its consequences on materiel readiness was difficult to attain.

d. Of particular importance to the Services is the condition of major items of equipment used in SE Asia that are to be retained within the Service inventory. The actual condition of this equipment cannot be evaluated until its return to depot maintenance facilities. Therefore the Services need to retain sufficient capability to define and accomplish this workload. However, supplemental civilian personnel ceilings authorized to depot maintenance facilities to meet added requirements imposed by the SE Asia contingency are being reduced. The Services are concerned that the organic depot maintenance capability to be retained as a result of ordered personnel reductions will be insufficient to cope with the anticipated but undefined workload to be received.

7. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) Throughout the Vietnam era, assignment of Service priorities provided adequate maintenance to deployed forces, but often at the expense of nondeployed units and lower priority programs (paragraphs 2a(1), 3a(4), 3b(1), 4a, and 5).

(2) The known and reported Service backlog of deferred maintenance was more than $900 million as of 1 November 1969 (paragraphs 2b, 3c(2), 4a, 4b(5), and 5).

(3) Reparable components, aircraft, and aircraft engines accounted for over 60 percent of the total reported repair costs of deferred maintenance (paragraphs 2b, 3c(2), and 5).

(4) The Services have not developed adequate techniques for predicting the impact and the resulting costs of maintenance deferrals (paragraph 1b).

(5) The Vietnam conflict generated a requirement for supplemental funding to overcome maintenance deficiencies deferred in prior years (paragraphs 2c(2), 3a(1), (2), (3), 3b(1), and 5).

(6) Lack of funding was identified by the Services as the most singular cause of deferred maintenance (paragraphs 2a(1), 2c(1), 3a(1), (2), (3), (4), 3d(2) and 5).

(7) Much of the equipment to be returned from SE Asia will require rehabilitation: costs cannot be determined until the equipment is returned and inspected (paragraphs 2c(3), 3b(4), 3c, 3d(2), and 5).

(8) There is a clear indication that further deferral of selected maintenance on inactive Reserve Fleet ships may result in unacceptable deterioration through destructive corrosion from lack of dehumidification or postponement of repairs in drydock (paragraph 3a(7)).

b. Recommendations. The Board recommends that:

(MT-10) Service deferred maintenance be stratified to identify those hard-core requirements for support of readiness objectives and the segments of deferred maintenance requirements, including those not in hard-core requirements, where there is a clear indication that a significant adverse impact will result from further deferral (conclusions (4) and (8)).

CHAPTER VIII
MAINTENANCE SUPPORT CONSIDERATIONS DURING CONCEPT AND DEVELOPMENT

1. INTRODUCTION

a. "We began this operation in Vietnam with approximately 250,000-300,000 line items (secondary items and repair parts). As a practitioner of logistics in all ranks from private to my present rank, in jobs from supply clerk to my present job, I believe that it is not visionary to indicate that we should be able to do this job over here with an authorized stockage list of between 15,000-25,000 lines—or less than 10% of what we started out with. To do this, of course, we must push standardization, real time cataloging, and a direct exchange-modular maintenance system which does not require piece parts and a high degree of personnel skills in forward areas. In Vietnam today we are trying to support a piece part/forward area repair system requiring hundreds of thousands of parts and many thousands of supply clerks and mechanics. It is not working."[1]

b. "The supply difficulties experienced at Cam Ranh Air Base and between the base and AFLC, clearly indicate that present systems are too complex, too sophisticated, and generally incompatible with the inherent simplicity of support systems for mobile flexible forces."[2]

c. "My ships are burdened with so-called sophisticated equipment which have wonderful 'press clippings' concerning their performance. Unfortunately, they won't work when we need them. Those complex systems are generally unreliable and very difficult to maintain. When they work, their performance is usually quite good. However, I would gladly sacrifice some performance for the sake of reliability and maintainability. My ships need systems that work when they are needed to work. They don't need any more junk installed in them."[3]

d. The maintenance of materiel in the tactical zone in a combat environment has always created a logistic problem which involves the allocation of great numbers of men and materiel resources. In World War II and Korea the implements of war utilized were relatively simple and did not require, by present standards, highly trained technicians or sophisticated tools and test equipment to perform the required repairs. However, with the increase in technology and the development of newer and more complex weapon systems the requirements for maintenance have increased. The cost of these increased life-cycle support requirements, which a Navy survey indicates are six times the system acquisition cost[4] generated a JLRB review of maintenance support considerations during concept and development.

e. Service policies recognize the need to consider maintenance during development. In practice, maintenance is generally considered in early phases; however, experience has shown that design changes affecting maintainability, reliability, technical data, electronic test equipment and provisioning are frequently made without consideration of their long range impact. Further, requirements established in maintenance support and provisioning plans are frequently not fully satisfied because of a shortage of funds, changes in field support environment, or other reasons, all of which work to dilute the effectiveness of maintenance planning.

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[1] Maj. Gen. Joseph M. Heiser, USA, CG, 1st Log Cmd, Letter to Gen. F. Besson, Chairman, Joint Logistics Review Board, 20 March 1969.

[2] Gen. Kenneth B. Hobson, USAF, CGAFLC, Letter, subject: Logistics Planning for Future Weapons Systems, 19 July 1967.

[3] Admiral H. P. Smith, USN, quoted in Integrated Logistic Support: From Concept to Reality, by Capt. Elmon A. Geneste, Jr., USN, ICAF, 1969, p. 2.

[4] U.S. Navy, Briefing to Equipment Maintenance and Readiness Council, 25 April 1969.

f. The role of maintenance in developing logistics support for a weapon system is better understood when viewed graphically (Figure 32). Note that the maintenance engineering plans, developed in consonance with the Five Year Defense Program, provide the baseline from which supply, personnel, facilities, procurement, and transportation requirements are developed. The interdependence of these facets of the logistics system makes it essential that management have visibility of the total spectrum in order that decisions and actions are effected in light of their total impact, not on a discrete or isolated function or subelement basis.

g. The potential impact of reliability and repair level decision on total logistic resources is multiplied as weapon systems become more complex. Figure 33 illustrates the large number of components with individual reliabilities and repair decisions which are involved in the F-4 aircraft weapons system.

h. The Services, the Office of the Secretary of Defense, and industry have been active in developing techniques to provide the needed visibility and have jointly developed the Integrated Logistics Support (ILS) concept as defined in DOD Directive 4100.35. This concept has been described in detail in DOD Guide 4100.35G by providing a systems engineering approach to the total logistic support function. The major maintenance elements of this discipline and their relationship to the system life cycle are depicted in Figure 34. The ILS system is intended to serve as a management technique for providing visibility of, and discipline to, the several logistic planning and support functions which are necessary in providing support to an item of equipment or weapons systems and may be abbreviated for off-the-shelf or minor equipment procurements or expanded for specialized or complex systems.

i. The DOD Guide 4100.35G identifies the major milestones in logistic support planning, several of which require techniques or methods for accomplishment which currently are not available for general use. The Guide and Figure 34 emphasize planning as the key to total logistics support. While this analysis has always been an essential requirement, the techniques, data, and timing vary among the Services and among weapon systems. The repair level decision portion of the maintenance engineering analysis is an outstanding example of the different methods and approaches being used to accomplish the analysis. The most detailed implementing directives available are NAVMAT Instruction 4000.20 and Specification MIL-M-24-365 (Ships), published by the Navy.[5]

2. DISCUSSION

a. The major impact of the maintenance level decision within the total logistics process is twofold: first the economics involved in the determination to include manpower, test, and diagnostic equipment, spares and repair parts, personnel training, and transportation, to cite the major considerations, and second, the correlation to the Service mission and material readiness. There is a trend to determine levels of repair on the basis of quantification which is immediately associated with procurement cost, since the contractual specification leads to this deduction. Thus, other elements of significant impact—environment, personnel availability, skills, and operational schemes—are not placed in the proper perspective to correctly define their influence and assess their values.

(1) In the design of modern weapon systems, it is essential that adequate attention be given to optimization of the level of repair (including support of the repair process and repair results). Optimum maintenance is achieved over a system's total life cycle if the alternatives selected minimize total system cost for a specified system effectiveness.

(2) From the standpoint of overall weapon system readiness, it is somewhat unrealistic to treat reliability and maintainability as two separate and distinct concepts. Readiness is the probability that a system—under specified operating and support conditions—will operate satisfactorily at any given time. Also, readiness is a function of both reliability and maintainability.

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[5] Proceedings of the Integrated Logistic Support Symposium, Sponsored by the Electronic Industries Association Engineering Department, Washington, D. C., March 7, 1968.

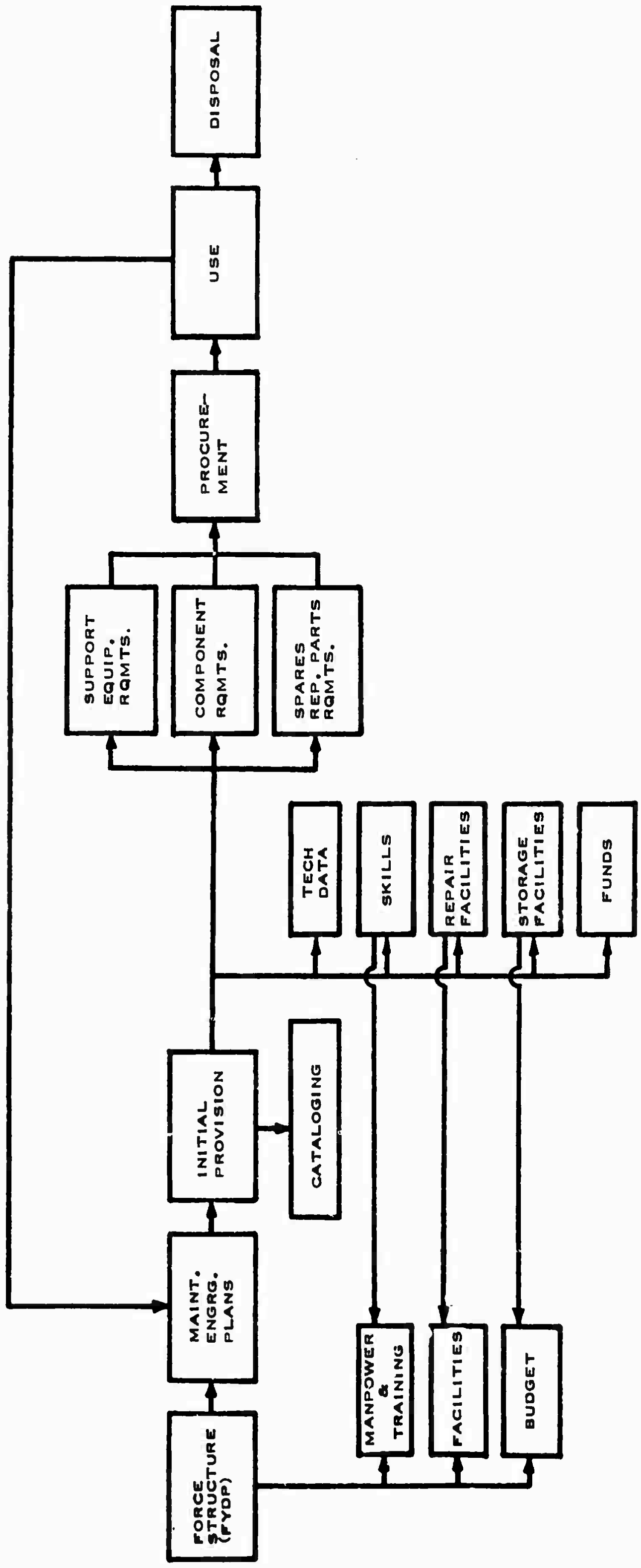

FIGURE 32. ROLE OF MAINTENANCE IN THE LOGISTIC SPECTRUM

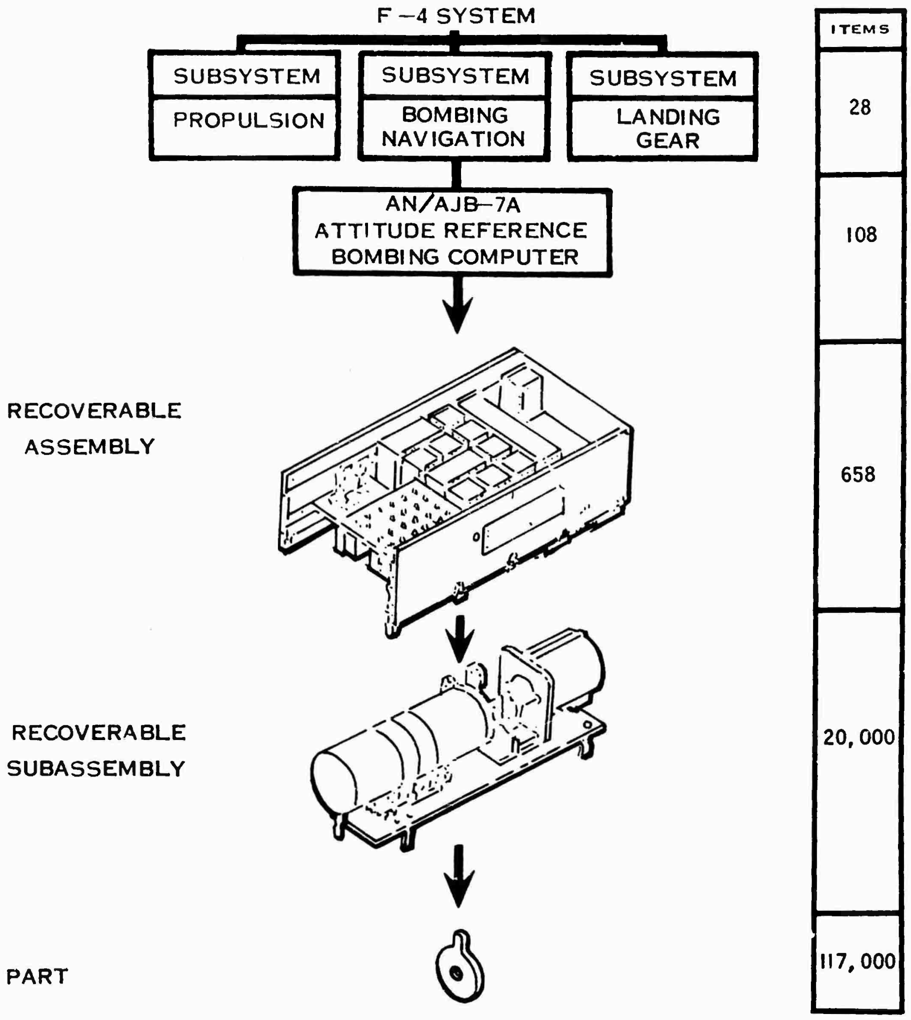

FIGURE 33. COMPONENTS ON F-4 SYSTEM TO BE EVALUATED DURING MAINTENANCE ENGINEERING ANALYSIS

Source: Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relations, Phase I Report, 23 June 1966.

Accordingly, and within the parameters of a weapon's desired availability, the designer may elect to trade off an investment in reliability against an investment in maintainability. Further, and to the extent that a system's reliability index may be too low, a compensating design effort must be focused on the maintainability index and vice versa.

(3) While the concepts of reliability and maintainability are by no means new, past efforts to achieve them have been more or less in the form of intuitive qualitative design judgments. Recently, because of advances in design technology, hardware fabrication processes, and statistical prediction techniques, significant breakthroughs are being achieved in the maintainability and reliability characteristics built into complex weapon systems. Success on these achievements, however, is still dependent on thorough testing and demonstrations, as indicated by the experience with the NS-17 guidance and control system for the MINUTEMAN II (Appendix A).

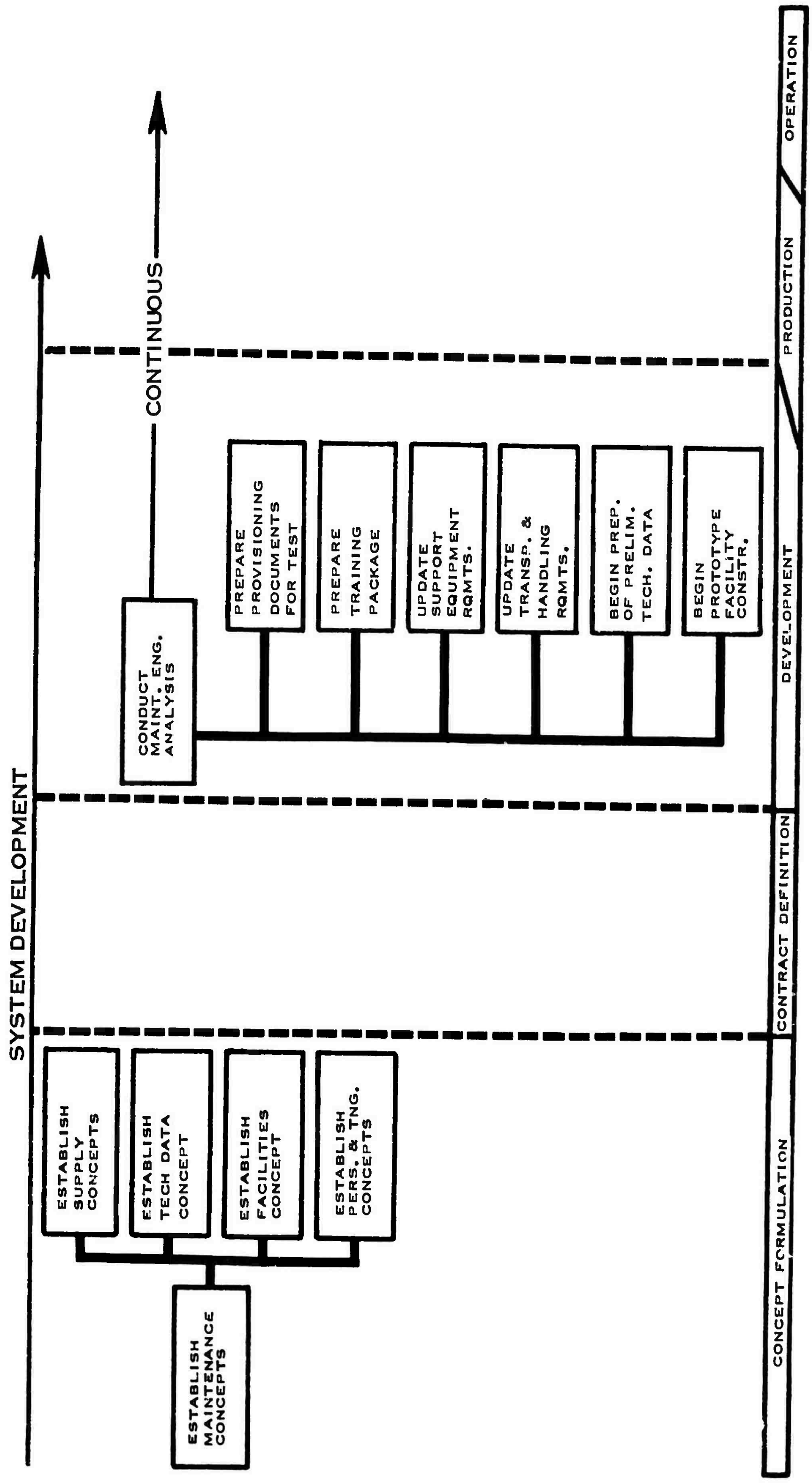

FIGURE 34. MAJOR MAINTENANCE MILESTONES IN EQUIPMENT DEVELOPMENT

(4) The planned reliability of the NS-17 guidance and control system was predicted by design engineers based upon the performance experienced with the NS-10. Actual performance of the NS-17, when installed, reflected failure rates six times higher than predicted. Use of state-of-the-art micro-miniature electronic modules and major changes in the inertial instrument in the NS-17, as compared to the previous NS-10 model, were determined to be primary causes for the poor performance. The reliability program had been drastically reduced, based on the assumption that the NS-10 reliability experience, and the predicted reliability of new modules, could be utilized on the NS-17.

(5) Indeed, reliability and maintainability design engineering has achieved such a degree of precision that industry has just recently become willing to contractually guarantee, in quantifiable terms, both mean time to repair (MTTR) and mean time between failure (MTBF).

(6) The logistical implications of this newly acquired ability to quantify and predict levels of maintainability and reliability are immense. To the extent that reliability is predictable, the logistician can now predict the frequency with which a system will require maintenance attention. Also, and to the extent that maintainability is predictable, the level of maintenance effort and all the support that it entails can now be predicted.

(7) Further, this ability to quantify and predict levels of reliability and maintainability suggests at least a partial solution to the logistician's after-the-fact participation in weapon system development. Now, before a weapon system is produced, the logistician has the tools to identify the magnitude of the logistical effort in terms of resources and funds. To the extent that the logistic support package "price tag" is considered too high, the development project must either be abandoned or the hardware redesigned. In this manner then, the logistician using the lever of estimated support costs can influence the designer to "think logistics."

b. The adequacy and effectiveness of repair level analysis in current government-industry contracts were studied for the Joint Logistics Review Board by a panel of the National Security Industry Association. Their summary stated:

(1) "The establishment of a workable maintenance concept is influenced by many factors including the attitudes and internal policies of those organizational activities who participate in the support of the particular system or item of equipment.

(2) "The user tends to favor those maintenance concepts which minimize his reliance on other organizations. Thus, his tendency is to favor maintenance concepts which afford maximum field level repair capability with minimum demand on personnel skills and organizational resources. The 'Spares Buyer' tends to favor those concepts which minimize the dollar investment in spare items and which give him flexibility in source selection and re-procurement. Government and contractor operated repair facilities favor those concepts which result in a significant and predictable flow of reparables through the repair pipeline. The contractor tends to favor those maintenance concepts which place him in a favorable contractual position and which tend to improve the performance image of his product. The buyer has various orientations depending upon how he responds to the pressures of the other participants, but generally favors maintenance concepts which in their formulation do not violate contractual stipulations.

(3) "Ideally, the maintenance concept which evolves for a given system or equipment would meet the following requirements:

(a) It is acceptable to contractor management. (Approval of proposed maintenance concepts is a normal prerogative of management in contractor organizations.)

(b) It is acceptable to the Government's program manager. (This is usually a contract stipulation.)

(c) It is effective and workable in the user environment. (This is a requirement under the Integrated Logistics Support Concept.)

(d) The various elements of support can be designed to be mutually compatible and to collectively implement the maintenance concept. (This is a requirement under the Integrated Logistics Support Concept.)

(4) "In practice, however, the maintenance concept is developed in an environment of conflicting orientations and at each stage it can be, and usually is, influenced by one or more of those conflicting orientations. The net result is that often some (and occasionally none) of the four ideal requirements are satisfied by the resultant concept.

(5) "The concept of repair level analysis and the use of these analyses to influence design is in general misunderstood and sometimes mistrusted by both contractor and customer personnel. Isolated instances can be provided wherein results of these studies did assist in design formulation. Generally, however, we the defense industry, still design to performance requirements and the resulting logistics system is reactive to that design."

c. The Services have established policies under which developing agencies are required to perform repair level analyses on new equipment. These analyses incorporate economic and operational considerations and are performed by contractors or in-house personnel, with validation and finalization vested in the developing activity. The repair level decisions arrived at in the early phase of design form the basis for provisioning actions for repair parts, equipment, personnel, and facilities.

(1) The Services all have established guidelines and procedures to assist in the repair level decision. The procedures require consideration of all aspects of logistics support and the impact of the repair level decision on them. Industry and Service efforts have been directed toward development of computerized means of effecting the analysis of repair level decision impacts quantitatively. However, these analyses are generally limited to cost considerations. Impacts and alternatives such as environment and weapon system considerations must still be weighed based on professional judgment and qualitative factors.

(2) Qualitative characteristics are the direct result of management and engineering attention during design. A quality design reflects detailed attention to the reduction of manpower and skill requirements, a clear expression of maintenance requirements, and a minimum number of special tools and equipment.

(3) The quantitative characteristics are reflected in the operational rate, operational turnaround time, reaction time, and other mission requirements which can be numerically defined.

(4) Use of computerized analysis offers a potential means of assessing total system requirements on a timely basis. The manipulation of data manually becomes unmanageable when considering the interplay of the many factors involved in the repair level decision and relating them to the three levels of maintenance.

(5) The Navy-sponsored Level of Repair study performed by General Dynamics proposed rules and reviewed the methodology drawn from other Service and industry efforts. The study provides a rational basis for making level of repair decisions by:

(a) Considering all alternatives in the repair spectrum.

(b) Displaying the cost consequences for various alternatives.

(c) Ensuring that each alternative will provide an equal level of effectiveness.

(d) Allowing for overriding noneconomic considerations.

(e) Identifying the least costly alternative as the selected level of repair decision.

(6) A summary of this study and other repair level models is included in Appendix B. Each of these was developed for a specific application to the repair level decision; however, none is currently in common use.

(7) The DOD Integrated Logistic Support Planning Guide (DOD 4100.35G) with its goal the achievement of proper balance among operational, economic, and logistic factors utilizing management planning of specific tasks at the appropriate level of detail, has selected 10 activities or elements which make significant contributions to planning life cycle support. It further establishes the requirement for a close and dynamic working relationship between system and design and support management. Within these two parameters—the activities and the working relationship—there are facets of the repair level decisions interwoven into the matrix. With the influence on resource utilization attendant to where to repair, the repair level decision process should be attributed a stature coequal with those currently in the Guide.

(8) In the past, design considerations relating to maintenance and repair level decisions have frequently been resolved by assuming that the best design permits and facilitates a maximum degree of organizational and field level maintenance. Recent combat experience has demonstrated that cost-effectiveness considerations and the alternative operational environments of the weapon merit a greater degree of attention in the course of making repair level decisions in today's environment. It is also evident that such decisions must be made as an integral part of the system design since the investments made during the development and acquisition phases preclude or seriously inhibit subsequent reversal of repair level decisions during the operational phase. Changes to repair level decisions for in-use equipment have been made and proposed in several instances; however, the benefits are normally not as dramatic and implementation of the changes may be costly.

d. The effect of repair policies on the total logistics system was dramatically portrayed in Vietnam by the magnitude of the repair parts, supply, transportation, and personnel management problems experienced by all Services. Temporary modifications to policy, intensive management, expedited movement, and control and extensive use of civilians in the combat theater were but a few of the actions required to ensure effectiveness of the support. The Services' maintenance support experiences during the Vietnam era prompted a re-evaluation of current policies.

(1) Maintenance Support Positive is an Army program designed to bridge the widening gap between hardware complexity and available skills. The objectives of the program are to evaluate current maintenance allocation policies, develop revisions and evaluate their cost and system effects, issue revised guidance and implement on a phased basis. The program recognizes that differences exist between commodities and directs each commodity command to formulate, for evaluation, an optimum support concept.

(2) The Army Electronics Command has proposed significant changes in the authorized repair levels of mobile communication electronics equipment as a means of optimizing equipment performance and readiness while minimizing repair parts inventories. These changes have been recommended as a means of minimizing the requirements for distribution and management of costly repair parts to the numerous direct and general support maintenance units in the field. While the concept capitalizes on the fact that the equipment lends itself to airlift retrograde and resupply, it does not reduce the personnel or equipment requirements of maintenance units. The direct support maintenance effort is devoted to alignment, adjustment, and diagnosis, rather than repair of modules.

(3) The Air Force Project PACER SORT, initiated in 1967, was a program designed to evaluate the impact of reducing repair workloads in a combat environment, involving F-4C tactical fighter squadrons at Cam Ranh Bay, RVN. The effort provided an extensive data bank for use in future studies. Probably the most significant conclusion to be drawn from PACER SORT is the fact that major changes to repair level decisions affecting operational systems are difficult to effect and do not offer significant advantages, since equipment, personnel, and repair parts, provisioned under original repair concepts, constitute fixed costs which cannot reasonably be recouped.

(4) In 1969 the Air Force initiated a study of base level repair capability to examine the current Air Force policy for repair of aerospace recoverable components and to evaluate and develop recommendations for the most effective and economical means for conducting an Air Force repair program for recoverable components.

e. Repair level decisions must be arrived at early in the design phase of a weapon system in order to optimize on the advantages of built-in test, modular repair, improved technical data, and other technologies which offer economies in total life cycle support costs. In this context, technical data used to define a design and to produce, support, or maintain weapon systems or equipment has concerned OSD and the Services. Its impliciations are described in Appendix C. Repair level decisions on modern equipment exert increasing influences on resources of the total logistics systems of the Services. The ever-increasing inventory of electronic test equipment in the Services is an excellent example of this influence. The FY 69 inventory, as furnished by the Services, is given in Table 47.

TABLE 47

INVENTORY OF ELECTRONIC TEST EQUIPMENT

Service	Units of Equipment	Dollar Value
Army	453,296	$ 229,897,059
Navy*	1,122,000	1,520,000,000
Marine Corps	13,041	34,631,000
Air Force	2,324,684	1,763,650,908
DSA	6,479	25,321,171
Other**	4,501	21,635,124
Total	3,924,001	$3,595,135,262

*Includes Marine Corps aviation.
**Includes Defense Communications Agency, Defense Atomic Support Agency, and National Security Agency.

NOTE: This dollar value represents only the hardware portion of the inventory and excludes the value of software (the routines used to extend the capabilities of computers), personnel, training, technical data, and facilities to support the hardware.

(1) The cost and complextiy of test equipment, and its vital role in the repair process, make it imperative that decisions on its design and use must be made early in the concept and development phases. Early consideration also permits maximum adaptation of existing test equipment to new requirements and acts to reduce the undesirable proliferation of new makes and models.

(2) Tradeoff decisions are identified at key points within the development phase, at which considerations of design, operation, and support are weighed for their effect on the total life cycle. The tradeoffs, and the analysis of alternatives on which they are based, need to be performed on a quantitative basis, not on subjective or qualitative basis as is frequently done.

(3) One of the most significant tasks of the weapon system logistician is his participation in tradeoff decisions with the hardware's designer. In this role, the logistician "prices out" the support costs of alternative design options, such as design for throw-away versus design for repair. Then, within the parameters of overall system availability, the support costs of

one option are "bumped" against those of another option. In this manner then, it should be possible to buy the most availability at the least cost.

(4) The Joint Logistics Review Board reviewed one application of Integrated Logistic Support through the presentation of management and support concepts involved in the current Navy program for general purpose amphibious assault ships (LHA's).[6]

(5) The management applied to the guidance and control system of the MINUTEMAN II Missile System, described in Appendix A, illustrates the application of tradeoffs in developing support concepts.

3. ANALYSIS

a. "Department of Defense Directive 4100.35 defines integrated logistic support as a 'composite of the elements necessary to assure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle.'" The key phrases in the definition are: composite of elements, levels of maintenance, and life cycle. These terms require that logistics be considered early in the acquisition process and that all elements of logistic support be integrally planned for the entire operational life of weapon systems and equipment. In addition to a plan for operational performance of the weapon system, there must be a companion plan for its logistic support, and these plans must constantly be meshed if the system is to achieve optimum effectiveness.

b. "Essentially ILS is a management planning discipline. It provides controls that help to assure that a weapon system or major equipment will meet performance requirements, and also that it can be supported expeditiously and economically throughout its programmed life cycle. Integrated logistic support planning begins in the conceptual phase, before procurement of a new system or equipment; and it continues to be developed and improved through the contract definition and acquisition phases. Such planning assures that logistic support is systematically developed, and that it is managed as an integrated whole, with all the elements interlaced."[7]

c. The application of ILS to weapon system development requires inclusion of costs for the ILS discipline over and above other development and production costs. This inherent cost has frequently been the target when constraints require reductions in weapon system acquisition costs. Although experience with ILS is limited, there are strong indications that the investment in the discipline can effect significant savings in total life cost.

(1) "For example, a particular aircraft unit requires seventy aircraft to be available for operational use, an additional thirty are at all times undergoing field maintenance in the form of repair, periodic inspection, etc. Fifteen more are in the inventory as replacements during maintenance."

Equipment Available For Use Due to Maintenance:	
Operational	70
Field Maintenance	30
Depot	15

(2) "If the thirty that are down for field maintenance could be reduced to 15 by improved design, thereby permitting longer periods between inspection and fewer breakdowns, the maintenance cost per aircraft has been reduced, and the equipments available for operational use has been increased. Similarly, if the time between depot maintenance could be doubled, the number of aircraft available for operational use could be further increased. In this simplified example, the aircraft available for use would rise from 60% to approximately 80%."

[6] U.S. Navy, Naval Ship Systems Command, Briefing, subject: Amphibious Assault Ship General Purpose (LHA), 25 September 1969.

[7] Capt. Elmon A. Geneste, Jr., USN, Integrated Logistic Support: From Concept to Reality, ICAF, 1969.

(3) "This simple example is intended to address itself only to that aspect of the problem that can be affected by improved logistic support."[8]

(4) "As another example, Boeing has made some "firm estimates" of possible savings by including integrated logistic support planning in future weapon systems of the same fleet size and complexity as the B-52G aircraft. The company estimates savings of $1.04 billion, exclusive of depot costs, or 18 percent of the total program costs. These include the following estimated improvement percentages:

Item	Percent
Reduction in Maintenance Man-Hours per Flight Hour	46
Reduction in Downtime	43
Reduction in Failures per Flight	28
Reduction in Aborts per 1,000 Flight Hours	22
Increase in Operational Time	11

(5) "This is just one more example of the magnitude of the savings and increased operational availability (readiness) that can be expected if the integrated logistic support concept is included in the life cycle planning of a system."[9]

d. The application of system engineering disciplines should also result in major improvements in the field of electronic test equipment. The cost of this equipment, as previously indicated, contributes significantly to total system support costs. Despite efforts to standardize and develop multipurpose equipment, the inventory continues to grow and costs for peculiar equipment increase, yet desirable maintenance support considerations are still unresolved.

e. The concept of ILS recognizes and disciplines the many logistic support functions which must be considered in weapon system development. A significant shortcoming of the concept and its promulgation is the lack of discipline provided the other elements involved, namely research and development, procurement, and quality assurance. As currently published, DOD Directive 4100.35 and DOD Guide 4100.35G are primarily logistical policies, not total life-cycle policies. To attain the desirable goals envisioned, it is essential that the DOD and Service directives be extended to incorporate all elements involved in weapon system development.

4. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) The Services have in-being programs designed to evaluate current maintenance policies and to develop new support concepts (paragraphs 1 and 2c).

(2) The time to achieve maximum benefits from maintenance support considerations and to minimize life cycle support costs is early in the development of new equipment (paragraphs 1 and 2a).

(3) The concept of Integrated Logistic Support (ILS), as outlined in DOD 4100.35G, offers a means of highlighting the role and importance of reliability, maintainability, repair level decision, technical data, and electronic test equipment (paragraph 1).

(4) The DOD Integrated Logistics Support Guide (DOD 4100.35G) does not clearly identify the repair level decision in importance or its relationship to other elements established for planning life cycle (paragraph 2c).

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[8] Department of Defense, Integrated Logistic Support Need/Use Analysis Report, Appendix D, Council of Defense Space Industries Association Advisory Committee for Management Systems Control, March 1968.

[9] Ibid.

(5) Repair level decisions must be made on an item-by-item basis as early as practicable in the development cycle in order that required spaces, skills, facilities, repair parts, and technical data to support the decision may be provided (paragraphs 1, 2c, and 2e).

(6) The Services are developing organizations, training, and procedures to implement ILS; however, significant efforts are required to develop specific analytic techniques and procedures to evaluate alternatives and conduct vital tradeoff analyses (paragraphs 1 and 2c).

(7) More emphasis must be given reliability and maintainability as key considerations in the decision to produce a new item of military equipment (paragraphs 1 and 2a).

(8) The potential for reducing maintenance downtime and improving utilization of maintenance skills through increased application of automation to technical data systems warrants further intensive study, design, test, and evaluation (Appendix C).

(9) Integrated materiel management techniques can be applied selectively to high cost assemblies, thereby minimizing investment costs. An example is the MINUTEMAN Guidance and Control System (Appendix A).

(10) Theoretical or optimistic projections of reliability can create critical logistic problems when used as a basis for procurement of support requirements (Appendix A).

b. Recommendations. The Board recommends that:

(MT-11) The Office of the Secretary of Defense amend the Integrated Logistic Support Planning Guide (DOD 4100.35G) to include a defined element entitled Repair Level Decision (conclusions (3) and (4)).

(MT-12) The Services stress the elements of Integrated Logistic Support concerned with reliability, maintainability, repair level decisions, electronic test equipment, and technical data in the development of equipment (conclusions (1)-(5), (7), and (10)).

(MT-13) The Services continue to develop specific analytic techniques for evaluating reliability and maintainability and for performing repair level analysis based on these evaluations (conclusions (7)-(10)).

(MT-14) Since the DOD Guide is designed for use at the top management level, the Services should expand this guidance to provide detailed in-house guides and techniques for use in maintenance engineering, provisioning, and associated support planning functions (conclusions (5) and (10)).

CHAPTER IX
DEPOT MAINTENANCE

1. INTRODUCTION

a. Depot level maintenance facilities are maintained by the Army, Navy, Marine Corps, and Air Force to overhaul and make major repairs to military equipment. The Secretary of Defense requires the military services to develop organic depot maintenance facilities to accomplish that portion of the total maintenance workload determined to be most essential[1] by scheduling the facilities at 85 percent capacity on a 40-hour week.[2]

b. The maintenance plan of each Service provides for the refurbishment of equipment in addition to the procurement of replacements for major equipment and reparable components. The workload for depot level maintenance can be predicted from the utilization rate of force structure equipment, and the equipment determined to be most essential. Additional workloads result from combat damage and unprogrammed operational requirements which cannot be predicted. Organic depot level maintenance activities were called upon during the Vietnam era to perform a variety of such unprogrammed maintenance requirements.

2. DISCUSSION

a. Organic depot maintenance includes the in-depth maintenance of mission-essential equipment that can be extended to the repair of combat damage, instruction of contractor personnel when work is transferred to industry, and field support of the operational forces. Inherent capabilities provided each of the military services with depot maintenance teams in Vietnam to effect repairs that would normally have taken equipment out of service for long periods of time.

b. The depot maintenance activities of all Services have operated under the industrial fund concept since 1968 and have the latitude of accomplishing the maintenance workload within military facilities or under contract to industry. The Army and Navy placed about 30 percent of the maintenance workload under contract during the Vietnam era while the Air Force placed about 50 percent.

c. The depot maintenance activities of the military services are constrained by two control mechanisms: first, overall fund availability for depot maintenance, which must be divided between contractual and organic facilities; and, second, control of manpower ceilings applicable to organic depot maintenance. Recommendations on manpower controls are covered in the Financial Management Monograph.

(1) Army

(a) The Army met the increased depot maintenance requirements by the hiring of temporary employees, shifting personnel, or placing work under contract with industry. The distribution of work between organic and contract remained almost constant in dollar value for continental United States depots, as shown in Figure 35.

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[1] Department of Defense Directive 4151.1, Policies Governing the Use of Commercial and Military Resources for Maintenance of Military Materiel, 28 July 1960.

[2] Department of Defense Instruction 4151.15, Depot Maintenance Support Programming Policies, 24 June 1969.

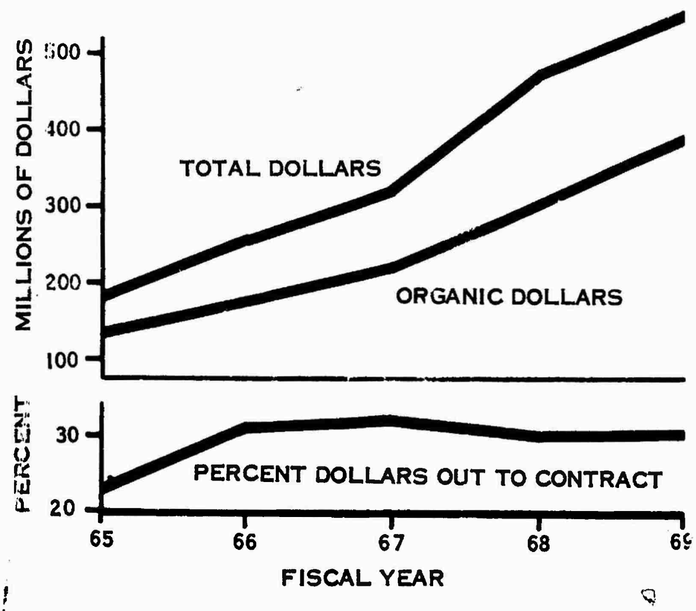


FIGURE 35. U.S. ARMY DEPOT MAINTENANCE

Source: U.S. Army Materiel Command periodic reports.

(b) Offshore depot maintenance was expanded in Japan, Okinawa, and Taiwan for automotive, construction, electronic-communication, general equipment, and marine craft (described in Chapter III). The value of depot maintenance performed by organic facilities in Okinawa and by contract maintenance in Japan was $38 million in 1969. Aircraft depot maintenance except for limited depot level repairs was performed in the continental United States (CONUS).

(c) Depot level field support of the operational forces in Vietnam was accomplished by contract in the case of airframe repair and vehicle overhaul. This contract support was comparable to the organic support furnished by the Special Techniques for Repair and Analysis of Aircraft Damage (STRAAD) teams of the Navy (Chapter IV) and the Rapid Area Maintenance (RAM) teams for the Air Force (Chapter VI).

(d) The use of contract maintenance in Vietnam added flexibility in a constantly shifting maintenance environment.[3] In addition, the requirement in a combat zone for personnel skilled in depot level repairs was proven by the Army maintenance experience in Vietnam where both aircraft and watercraft underwent depot level repair work. The distribution of organic Army and contract maintenance in the offshore area of Vietnam and the continental United States is discussed in Chapter III.

(2) Navy

(a) The organic aviation and shipyard depot level maintenance capability of the Navy permitted rapid response to emergencies and unscheduled repair work throughout the Vietnam era in spite of restrictive controls placed upon them. The Navy would normally remain independent of shorebased installations through the use of mobile maintenance equipment and the movement of unserviceable equipment to CONUS depots; however, the operational demand for serviceable equipment over an extended period of time made it expedient to expand ship repair facilities in Southeast Asia (see Chapter IV, Navy Maintenance).

[3]Department of the Army, Review and Analysis of DS Army Logistics System in RVN, July 65-August 69, Annex J, August 1969, p. J-15.

(b) Navy shipyards and Navy repair facilities were confronted with an increasing workload due to increased utilization of equipment and by labor union strikes which affected the completion of work placed under contract. The effect of personnel ceilings and overtime restrictions on the workload at naval shipyards is described in Chapter IV.

(c) Depot maintenance activities were subject to civilian personnel ceiling controls and formal numerical controls on overtime which constrained effective workload management. Industrially funded activities performed work on a reimbursable basis, and the imposition of ceilings was often inconsistent with the maintenance workload which the activity was funded to perform (described in the Financial Management Monograph, Chapter VII).

(d) The control of overtime funds has been used intermittently by the Secretary of Defense. Controls were in effect in FY 65, removed in FY 66, reinstated in FY 67, and removed in FY 69.

(e) Depot maintenance repairs were extended in-country as described in Chapter IV similar to the Air Force RAM teams and contract maintenance by the Army.

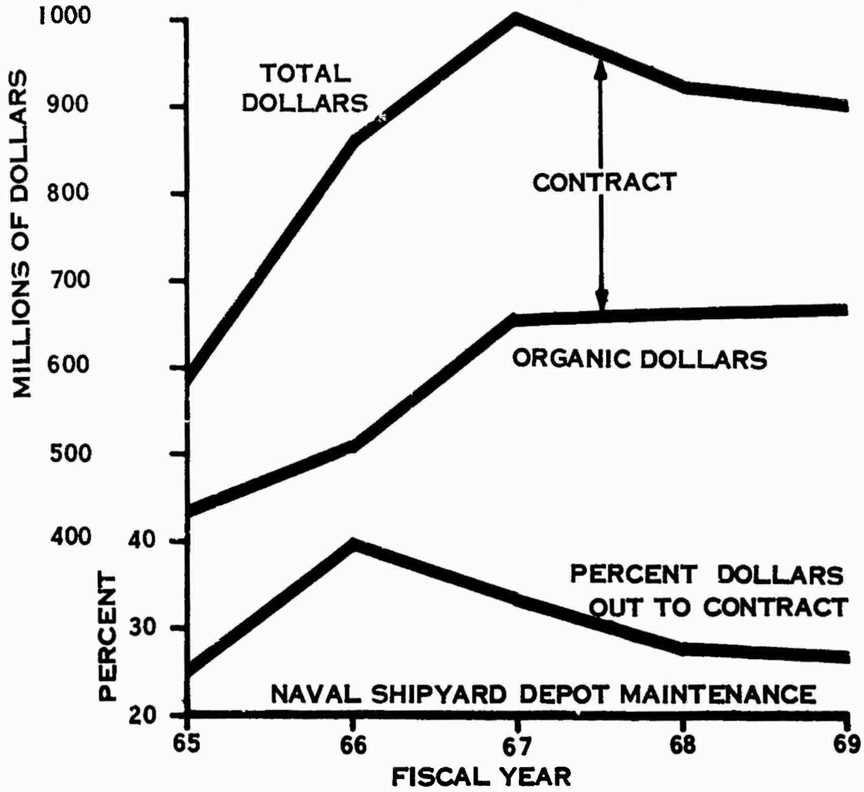
(f) The workload at naval aircraft rework facilities (NARFs) increased rapidly during the Vietnam era due to additional utilization of aircraft, combat-required modifications and combat damage (see Figure 36). The number of civil service employees required is compared to the number of employees authorized in Figure 37. The difference between the two curves represents work that could have been accomplished within existing NARFs, but had to be placed under contract because additional civil service personnel could not be hired. The effect of ceiling controls had the twofold detrimental effect of increased contract cost and not utilizing depot maintenance facilities to peak efficiency. A study was made of the work accomplished by NARFs and the cost of accomplishing the same work under contract. The study indicated that the total cost to the Navy was 139 percent of the NARF cost when contracts were used.[4] An example of problems incident to civil service ceilings and overtime constraints for NARFs is provided in the Financial Management Monograph, Chapter VII.

(g) The Secretary of the Navy requested that the Secretary of Defense remove the numerical controls on civil service ceilings and overtime funding for naval industrial funded activities on two occasions. The requests are still under consideration.[5]

(3) Marine Corps. Depot maintenance of Marine Corps ground equipment is directed toward support of the Fleet Marine Forces. Its organic facilities are depot maintenance activities at the two Marine Corps Supply Centers. The depot level capabilities of these facilities were extended overseas by means of technical assistance teams. The total depot requirements for the Marine Corps were accomplished by organic, interservice, and contractual support. In CONUS, this averaged $30 million for FYs 66 through 69. Significantly, its CONUS depot work force was a balanced civilian-military mix, with military manning at approximately 34 percent. The military personnel performed productive work and also received training to increase their skill levels. By this program, the Marine Corps has provided a rotational base for military maintenance personnel that extends from CONUS to overseas and return in developing skills from the organizational through depot level. Marine Corps aviation receives depot level support under the Navy procedures described in paragraph (2).

[4] Department of the Navy, Bureau of Naval Weapons, Aeronautical Depot Maintenance Cost Comparison Study, 23 February 1965 (revised 30 October 1965).

[5] Secretary of the Navy, Memorandum, subject: Improvements in Management Control Techniques, 5 May 1967; Assistant Secretary of Navy (Comptroller), Memorandum, subject: Civilian Employment Limitation, 19 February 1969.



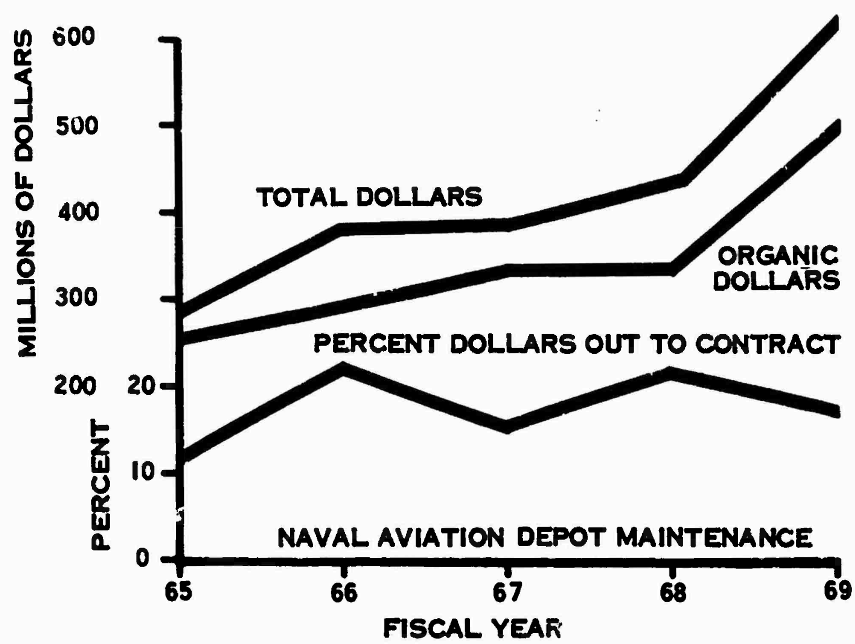


FIGURE 36. NAVAL DEPOT MAINTENANCE

Source: Naval Air Systems Command and Naval Ships Systems Commands periodic reports.

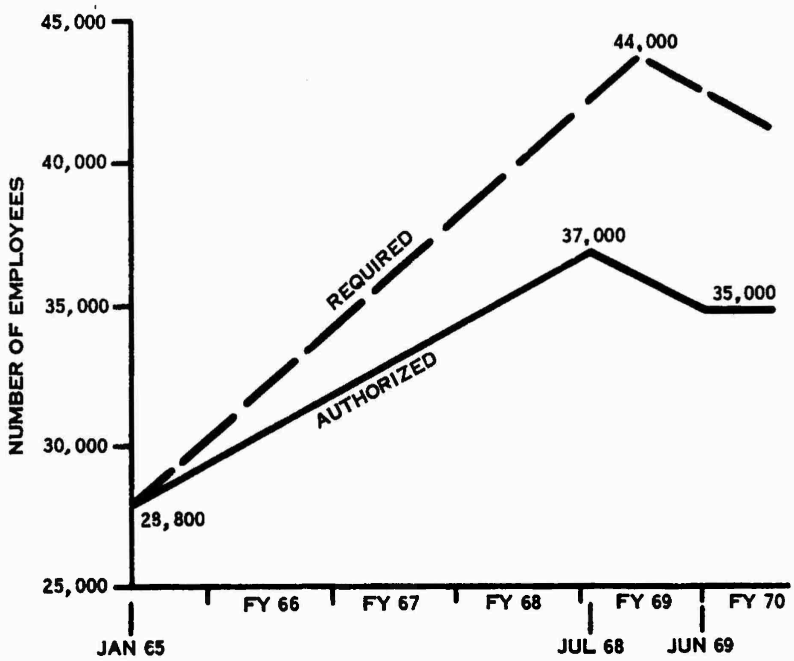


FIGURE 37. NAVAL AIRCRAFT REWORK FACILITIES MANPOWER

Source: Naval Air Systems Command, Briefing to JLRB, Naval Aviation Depot Level Maintenance Program, 8 May 1969.

(4) Air Force

(a) A steady erosion of manpower and facilities over the past several years with an ever increasing reliance on contractor support has reduced organic depot maintenance to a point where less than one-half of depot level work is being accomplished organically[6] (Figure 38).

(b) The Commander of the Air Materiel Command (later named the Air Force Logistics Command) established a policy in July 1953 which was essentially the same as that contained in DOD Directive 4151.1, dated 28 July 1960, and AFR 66-7. This policy specified that: "Potential resources required to accomplish the Air Force maintenance program will be established in peacetime so as to aid timely accomplishment of national emergency missions."[7] In implementing this policy, the following were to be adhered to:

> "(1) Develop and maintain a high degree of proficiency for D-Day maintenance support of tactical and tactical support (first-line) type aircraft and engines.
>
> "(2) Utilize existing depot facilities on a one-shift, forty-hour week operation so as to permit rapid expansion, with minimum interruption, to multiple shifts in the event of an emergency.

[6] Headquarters, Department of the Air Force, Briefing to the Joint Logistics Review Board, subject: Air Force Maintenance System, 9 May 1969.

[7] U.S. Air Force Logistics Command, Posture Analysis Report, 1 July 1969, Vol. I.

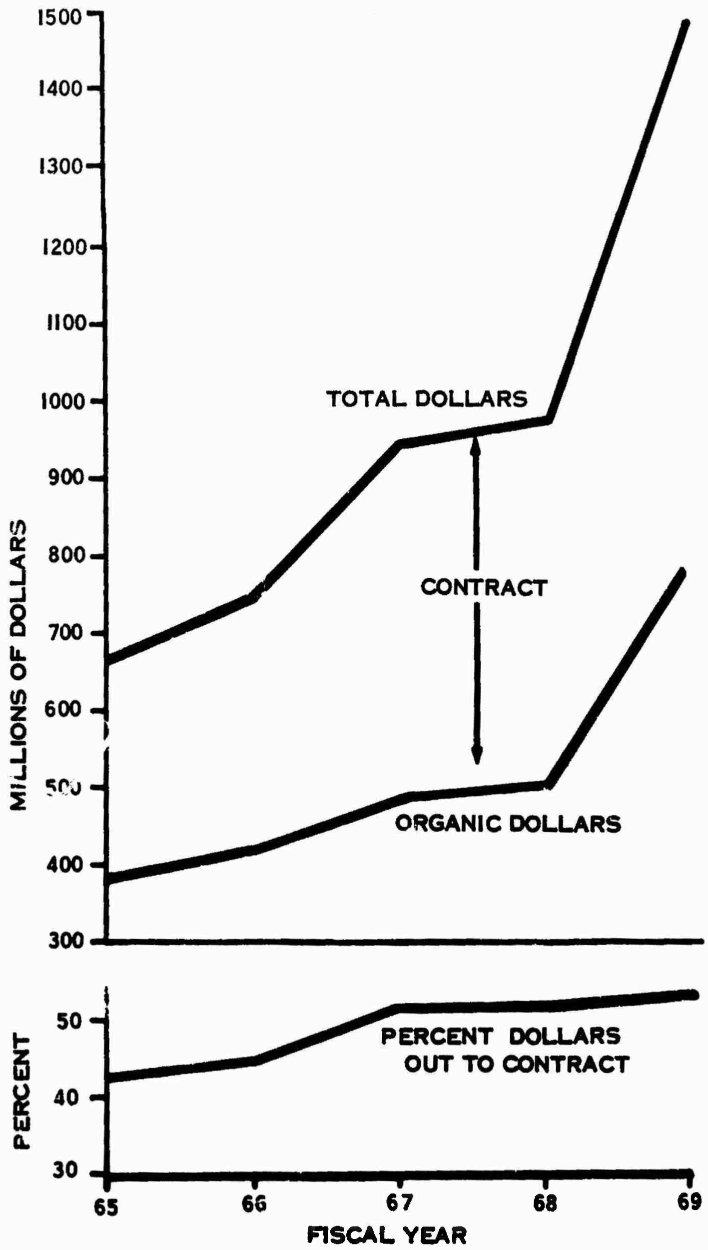


FIGURE 38. U.S. AIR FORCE DEPOT MAINTENANCE

Source: Headquarters, U.S. Air Force Briefing to the JLRB, Air Force Maintenance System, 9 May 1969.

"(3) Schedule, to the maximum extent practical first line aircraft and engines to the depots for overhaul, IRAN, and modification to insure preservation of a depot maintenance capability for D-Day support of Air Force combat wings.

"(4) Maintenance workloads beyond the one-shift capability of the depots were to be considered for accomplishment by contract.

"(5) Continue contractual maintenance programs without endangering the Air Force capability of accomplishing the maintenance mission during emergencies.

(c) "Based upon the evaluation of this policy the depot maintenance force within the Air Materiel Command was established at approximately 66,000 personnel. This labor force would provide for a sound mobilization base, a reasonable utilization of our depot facilities and a reasonable disposition of workload to industry."[8] This policy proved to be sound and continues to exist today with minor revisions. However, it has not been possible to follow the policy. Air Force maintenance depots have been reduced in number, manpower ceilings have been lowered, weapon systems have become more complex, and workloads have increased, and the work performed has gone from 100% organic after WW II to only 45% organic by FY 69.[9]

(d) "The loss in organic capability has been over the period of a major and continuing increase in depot maintenance requirements in support of Southeast Asia. Although authorization for 5,000 additional manpower spaces was made available during FY 66 to increase the depot maintenance workforce in order to accommodate the surge in SE Asia workload, this increase was less than one-third of the number of personnel required."[10] The depot phase-out program, wherein only 22 percent of the trained work force functionally transferred, required an extensive recruiting and training program to replace the 8,000 trained personnel lost to the maintenance work force and resulted in a combined loss of over 12.7 million man-hours of productivity and a significant increase in cost to the Air Force.[11]

(e) AFLC has been forced to increase the use of overtime in support of high priority depot maintenance requirements to an unprecedented level. During FY 68, depot maintenance facilities expended 2.8 million hours of overtime at a cost of over $14 million to meet the emergency and urgent demands of the operational commands for depot and field team support.

(f) The emergency created in 1948-1949 by the Berlin Airlift requirement brought industry in to assist the Air Force in its airframe and engine overhaul tasks. With the growth of complex missile and communications/electronics systems, more and more use was made of contractor assistance in performing depot level support. By 1952, prime airframe and engine contractors were faced with reduced workloads as a result of cut-backs in the production program. In order to help maintain an expandable production base, the Air Force adopted the policy of utilizing prime aircraft and engine manufacturers to supplement the accomplishment of depot level maintenance workloads on first-line aircraft and engines.

(g) A factor which must be considered in determining the level of the organic maintenance manpower base is the normally unprogrammed emergency on-site assistance which the Air Force Logistics Command (AFLC) must provide to the major commands for the accomplishment of field level maintenance and modification work that is beyond their capability. Of the total maintenance work force of approximately 34,000 direct workers, an average of 1,200 direct workers or 3.5 percent are in the field providing area assistance. One hundred fourteen of these field support people were assigned to the Rapid Area Maintenance (RAM) teams in SE Asia for repair of crash and battle damaged combat aircraft.[12]

(h) The flexibility of the organic work force to accommodate flight safety modifications of both depot and field level nature is vital to combat operations. At one time AFLC provided 479 F-4 skilled civilian and military personnel to perform on-base flight safety and urgent modifications in SE Asia, such as egress seat modification, AIM-4D installation, Mark I Mod-0 glide weapon modification, secure speech, document camera, ORAN D installation,

[8] U.S. Air Force Logistics Command, Posture Analysis Report, 1 July 1969, Vol. IV, pp. 6-8.
[9] Ibid.
[10] U.S. Air Force Logistics Command, Letter, subject: Review and Expenditure Control Act of 1968, 11 October 1968, Chapter 1 of Attachment, p. 4.
[11] U.S. Air Force Logistics Command, Posture Analysis Report, p. 6-2.
[12] U.S. Air Force Logistics Command, Revenue and Expenditure Control Act of 1968, p. 9.

KR-18 camera, and chaff flare dispenser. In addition, unprogrammed emergency workloads on the first line weapon systems were performed, such as the fleetwide modification of the KC-135 tail fin at a cost of over $1 million, installation of MOD 2300 on 16 B-57 aircraft at a cost of over $5 million, and the fleetwide rework of the F-4 aircraft resulting from the potting compound reversion. This program required the use of over $5 million in unprogrammed resources during FY 69.

(i) Continued erosion of the skilled organic work force severely limits AFLC ability to rapidly respond to the demands for these types of emergency requirements.

(j) The Air Force Logistics Command in March 1969 organized a "Blue Ribbon" task force called the AFLC Posture Analysis Study Group to develop command policies and standards regarding utilization of maintenance facilities. In this report, published 1 July 1969, the study group summarized the problem as follows: "One of the primary objectives of Posture Analysis was to present to the Air Staff a recommendation to reestablish a greater organic depot maintenance capability as a part of the peacetime in-being posture to provide a base for rapid expansion in support of the Air Force emergency mobilization needs. The development of this expanded capacity to be phased over a period of time would permit a gradual deemphasis of contract support as a primary supporting source for depot level maintenance requirements. AFLC organic maintenance has been reduced from a work force of almost 63,000 in 1960 to less than 49,000 at the end of FY 69. Notwithstanding the loss of depot maintenance facilities during this period, overall facility utilization within the continuing AMAs has declined to an uneconomical point. Ineffective utilization of maintenance facilities equates to $192 million. The fact that this position exists today, however, does provide AFLC a solution to the manpower problem. By improving the effectiveness of facility utilization of current assets (valued at $468 million at today's replacement costs), the move from a contract base to a larger organic base can be made provided relief can be had from the manpower constraints. Proposed buildup of the manpower force would increase facility utilization in the aggregate from the FY 69 posture of 59% to 68% in FY 74 on a single shift 40 hour work week. Conversely, without the buildup in personnel, the utilization will drop to 50% in FY 74. The Air Force erosion in the organic workforce has resulted in degradation of support to the customer commands, and increased manhour costs caused by instability of the workforce with attendant inefficiency and loss of production momentum in increased training. Importantly, the adverse manpower decisions have significance in causing the loss of organic capacity to meet the exigencies of an all out nonnuclear conflict against a major opponent and the ability to adequately respond to a second front during a conflict such as presently exists in Southeast Asia...."[13]

(k) The AFLC posture Analysis effort developed the necessary manpower requirements to establish by FY 74 an organic capability to adequately respond to the AFLC mission in peace and war (Figure 39). "The organic workload requirements increase from approximately 53 million (45% of total W/L) manhours in FY 69 to 69 million (66% of total W/L) manhours in FY 74. Conversely, contract workload requirements decrease from 60 million (51% of total W/L) manhours to 31 million (29% of total W/L) manhours. The remaining interservice support workload requirement increase from 4 million manhours to 5 million manhours, representing a 2% increase to the total requirements."[14]

3. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) Responsive depot maintenance support during the Vietnam era resulted from a viable organic base, capable of adjusting to meet the varying demands of a changing force structure, and from the experience and technical competence of the work force (paragraphs 2a, 2b, 2c, and 2d).

[13] U.S. Air Force Logistics Command, Posture Analysis Report, p. 3-1.
[14] Ibid., p. 6-34.

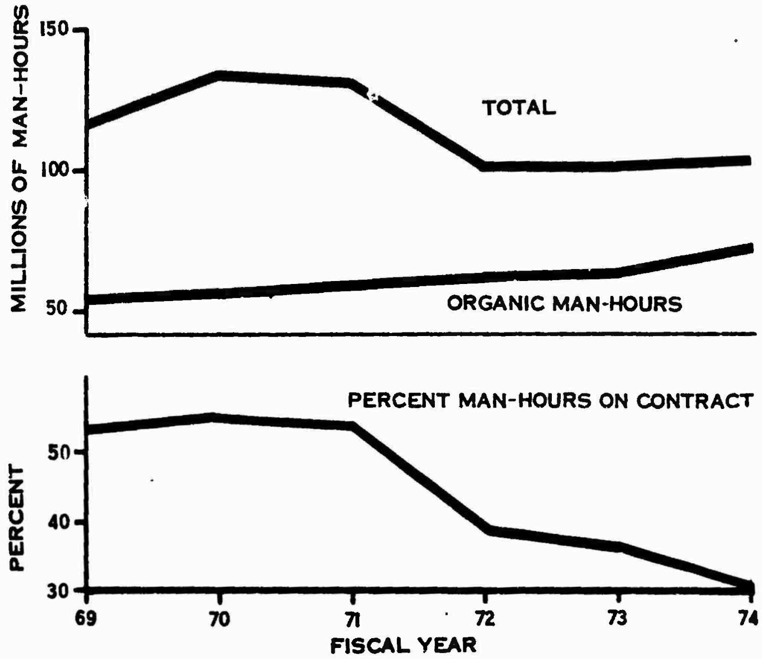


FIGURE 39. AIR FORCE LOGISTICS COMMAND PROPOSED DEPOT MAINTENANCE WORKLOAD DISTRIBUTION

Source: Air Force Logistics Command, Posture Analysis Report, 1 July 1969, Vol. IV.

(2) The extension of organic depot repair capability through repair team concepts by the Services proved essential to the repair of equipment in Vietnam (paragraphs 2a, 2b, and 2d).

(3) Manpower ceilings had adverse effects on industrially funded activities as discussed in the Financial Management Monograph, Chapter VII, paragraph 4 (paragraph 2).

(4) Industrially funded activities were constrained by restrictions on overtime in FY 1965, 1967, and 1968 (paragraph 2b).

(5) The organic-contract mix for depot maintenance varies considerably among the Services, with a general trend toward an increasing quantity going to contract (paragraphs 2, 2a, 2b, and 2d).

b. Recommendations. The Board recommends that:

(MT-15) In recognition of the essentiality of a viable and responsive depot maintenance capability, the Services and the Office of the Secretary of Defense take steps to achieve a reasonably stable posture of their organic depot maintenance structure in the continental United States (conclusions (1), (2), and (5)).

(MT-16) The Secretary of Defense continue to exclude industrially funded activities from overtime limitations (conclusion (2)).

CHAPTER X

MAINTENANCE MANPOWER

1. GENERAL

a. Introduction

(1) A study of maintenance with its related problems is obligated to discuss its most important asset, qualified people. This chapter will serve as the discussion paper for those personnel problems which affected maintenance manpower during the Vietnam era.

(2) During the initial phase of the Joint Logistics Review Board (JLRB), senior commanders both active and retired were asked to recommend logistics problem areas worthy of study. Numerous replies indicated that in Vietnam, particularly during the early buildup, logistics personnel and units were either not available in the quantities required or lacked professional expertise when they arrived in-theater. JLRB research also revealed that even though a Service was able to fulfill its requirements with qualified personnel during the first year, the provision of equally qualified personnel during the succeeding years taxed the Service's overall resources in certain skill areas. The major portion of the skill shortage problem occurred in the Army—a fact which is understandable considering the size of the Army commitment to Vietnam, the rapidity of the Army buildup, and the peculiarity of a 2-year draftee comprising a major portion of the force. Since the Army appears to be in the most untenable maintenance manpower position in respect to qualified skilled repairmen, this paper will primarily cite figures from Army data.

b. The Manpower Problem

(1) The indispensable element in a military organization is people, not hardware. The Vietnam conflict with its requirement for people presented personnel problems which heretofore had not been encountered by the Services. The ground rules for the conflict as laid down by the executive and legislative branches of the Government resulted in a change in previous national military manpower policy. In turn, this policy change affected the alacrity with which the military services met their manpower requirements.

(2) National manpower policy has always been based on the assumption that once military manpower requirements have been established, they will be met. However, this has not always been the case insofar as the timeliness of meeting these requirements is concerned. Since World War II, vastly expanded United States commitments under an unsteadily prevailing "half peace" have required military strengths ranging in size from slightly under 1.5 million men in the early postwar years, to a peak of 3.7 million during the Korean War. to an end FY 69 strength of 3.5 million men.[1] Table 48 indicates this steady increase in the size of the forces. The management of these forces presented a challenge in matching an individual's skill to the proper billet. The difficulty of this task was compounded by the annual rotation of a half million men to Vietnam.

(3) In recent years there has been no shortage of actual manpower numbers serving as a resource for the Armed Forces. Unfortunately, however, numbers are not the only consideration involved in maintaining the Services at their authorized strength. The principal requirement is to acquire and then retain in peacetime the talent that is necessary for a limited war engagement or for use as a mobilization base for a greater than limited war expansion. The

[1] U.S. Congress, House of Representatives, Committee on Appropriations, Hearings, subject: Military Personnel, 90th Congress, Second Session, 1969, Part 5.

Services acquire their manpower principally through voluntary recruitment, but resort to the draft when enlistments do not sustain the size of the force required or when an emergency requires forces of extraordinary size. Table 49 is a resumé of the volunteer programs for each Service.

TABLE 48

SUMMARY OF MILITARY PERSONNEL STRENGTH
(1967-1969)

FY 67	Army	Navy	Air Force	Marine Corps
Officer	127,600	81,677	134,932	23,592
Enlisted	1 240,454	665,226	758,198	261,677
Total	1,368,054	746,903	893,130	285,269
FY 68				
Officer	139,517	85,597	136,718	24,555
Enlisted	1,315,979	678,360	742,889	282,697
Total	1,473,579	763,957	879,607	307,252
FY 69				
Officer	145,689	90,730	133,413	25,698
Enlisted	1,329,904	699,577	729,343	284,073
Total	1,497,060	790,307	862,756	309,771

TABLE 49

VOLUNTEER PROGRAMS

Service	Minimum Active Duty	Basic Training	Comment
Army	3 years	8 weeks	Only service that guarantees specified training for high school graduates. Widest choice of schools.
Navy	4 years	7-9 weeks	Three-year enlistments available in some areas.
Air Force	4 years	6 weeks	Shortest basic; long enlistment.
Marine Corps	2 years	8 weeks	Shortest enlistment; no active reserve obligation after discharge. Toughest training. Probable combat duty.
Coast Guard	4 years	9 weeks	Fewer "military" duties than other services. Long enlistment.

Source: U.S. Congress, House of Representatives, Committee on Appropriations, Hearings, subject: Military Personnel, 90th Congress, Second Session, 1969, Part 5.

(4) It should be noted that even though the Army has 2-year minimum tours, it, primarily because of its size, must resort to the draft to fill its ranks. Draft calls began to double in April 1965 and steadily increased to a high of over 40,000 in December 1965. Table 50 is a summary of enlisted personnel procurement from July 1965 through January 1966. It reflects nearly a 100 percent increase in total Department of Defense (DOD) inductions to meet the requirements of Vietnam and also provides an insight into the small number of reenlistments

after the first term of service expired. Table 51 is an example of the increase in draft calls and the total number of inductees with which a Service must work.

TABLE 50

SELECTIVE AND VOLUNTARY SERVICE
(July 1965 - January 1966)

DOD Personnel Replacement Status	July 1965	Aug. 1965	Sep. 1965	Oct. 1965	Nov. 1965	Dec. 1965	Jan. 1966
DOD Personnel Replacement Status	82,739	85,800	99,348	95,366	99,955	88,104	107,778
Inductions	18,861	17,863	24,774	29,302	35,216	36,482	35,269
First Enlistments	36,803	45,957	50,245	43,144	41,164	28,659	48,435
Immediate Reenlistments	20,681	16,888	17,821	15,571	17,488	18,448	17,236
Other Reenlistments	1,470	1,642	1,543	1,429	1,432	1,159	1,390
Reserves to Active Duty*	4,924	3,450	4,965	5,920	4,655	3,356	5,448
Total Army	37,802	36,421	44,357	45,037	53,337	54,189	52,703
Inductions	18,852	17,858	24,769	26,718	31,732	36,446	27,630
First Enlistments	9,329	11,836	12,557	12,688	14,581	10,021	18,255
Immediate Reenlistments	8,902	5,828	6,109	4,889	6,414	7,139	6,105
Other Reenlistments	657	806	585	572	520	494	605
Reserves to Active Duty	62	93	337	170	90	89	108
Total Navy	20,358	20,524	24,291	23,147	16,613	16,651	18,426
Inductions	--	--	--	2,582	3	--	--
First Enlistments	12,062	14,302	16,552	13,838	10,664	10,746	12,955
Immediate Reenlistments	3,150	2,536	3,497	2,727	2,691	3,514	2,847
Other Reenlistments	535	574	514	437	349	232	262
Reserves to Active Duty	4,611	3,112	3,728	3,563	2,906	2,159	2,362
Total Marine Corps	5,621	6,072	7,765	7,040	11,190	4,694	16,558
Inductions	9	5	3	2	3,481	36	7,639
First Enlistments	4,629	5,055	5,988	4,132	5,090	2,766	5,086
Immediate Reenlistments	790	660	770	637	880	727	810
Other Reenlistments	83	110	110	82	89	64	70
Reserves to Active Duty	110	242	894	2,187	1,650	1,101	2,953
Total Air Force	18,958	22,783	22,935	20,142	18,815	12,570	20,091
Inductions	--	--	2	--	--	--	--
First Enlistments	10,783	14,764	15,148	12,486	10,829	5,126	12,139
Immediate Reenlistments	7,839	7,864	7,445	7,318	7,503	7,068	7,474
Other Reenlistments	195	152	334	338	474	369	453
Reserves to Active Duty	141	3	6	--	9	7	25

*Includes National Guard.

Source: Directorate for Statistical Services, Office of Secretary of Defense.

TABLE 51

SELECTIVE SERVICE
(July 1964 - March 1966)

Fiscal Year	Selective Service Calls				Inductions				Inductees on Active Duty				
1965	Total	Army	Navy	Marine Corps	Total	Army	Navy	Marine Corps	Total	Army	Navy	Marine Corps	Air Force
Jul 1964	8,000	8,000	--	--	7,801	7,798	--	3	210,659	210,585	--	74	NA
Aug	3,300	3,300	--	--	3,856	3,849	--	7	209,161	209,084	--	77	NA
Sep	6,200	6,200	--	--	4,799	4,792	--	7	207,057	206,975	--	82	NA
Oct	6,600	6,600	--	--	6,207	6,205	--	2	208,768	208,687	--	81	NA
Nov	8,600	8,600	--	--	7,906	7,903	--	3	211,153	211,071	--	82	NA
Dec	7,800	7,800	--	--	7,793	7,789	--	4	213,559	213,478	--	81	NA
Jan 1965	5,400	5,400	--	--	5,858	5,854	--	4	214,668	214,587	--	81	NA
Feb	3,000	3,000	--	--	3,705	3,699	--	6	211,418	211,338	--	80	NA
Mar	7,900	7,900	--	--	8,250	8,247	--	3	210,706	210,626	--	80	NA
Apr	13,700	13,700	--	--	13,761	13,756	--	5	216,025	215,940	--	85	NA
May	15,100	15,100	--	--	14,707	14,702	--	5	222,495	222,405	--	90	NA
Jun	17,000	17,000	--	--	17,912	17,903	--	9	233,973	233,883	--	90	NA
Total	102,600	102,600			102,555	102,497		58					
1966													
Jul 1965	17,100	17,100	--	--	18,861	18,852	--	9	245,103	245,010	--	93	NA
Aug	16,500	16,500	--	--	17,863	17,858	--	5	251,206	251,109	--	97	NA
Sep	27,400	27,400	--	--	24,772	24,769	--	3	265,574	265,477	--	97	NA
Oct	33,600	29,000	4,600*	--	29,302	26,718	2,582	2	281,171	278,494	2,582	95	NA
Nov**	32,450	28,400		4,050	35,658	32,111	--	3,547					
Dec***	40,200	40,200	--	--	39,053	39,053	--	--					
Jan 1966	38,280	29,300	--	8,980	39,024	31,024	--	8,000					
Feb	25,400	26,400	--	3,000	27,100	22,500	--	4,600					
Mar	25,200	21,200	--	4,000									

*Reduced to 2,600.
**Original call for 36,450 reduced to 32,450.
***Original call for 45,224 reduced to 40,200.

Source: Directorate for Statistical Services, Office of Secretary of Defense.

(5) The tremendous influx of untrained personnel at the bottom of the grade structure had a significant impact on the ability of the Services, particularly the Army, to maintain its equipment on a worldwide basis while still providing adequate maintenance support for Vietnam. It is evident that the sheer number of personnel that had to be properly processed, trained, gainfully employed, and managed would give rise to several problems during a logistic buildup.

c. Manpower Effects of the Vietnam Logistical Buildup

(1) Magnitude of the Buildup. The decision made in March 1965 to commit major U.S. ground combat forces in Vietnam produced the hurry-scurry phase of the buildup and deployment. The logistics support force in-country in early 1965 consisted of 20,000 U.S. personnel, supporting a total U.S. commitment of approximately 27,000 combined American Forces.[2] This buildup of combat forces necessitated a concurrent deployment and/or activation of supporting maintenance organizations. By the end of 1966 the logistics support force totaled approximately 45 percent of the overall troop commitment of 330,000 personnel, and by 1967 had dropped to 40.3 percent.[3] Figure 40 depicts the rapidity and size of the buildup, with a Service breakout shown for May 1966. Experience indicates that the personnel problems experienced by the Services with regard to the provision of qualified maintenance people and units were in direct proportion to the number of forces each Service had in the field.

(2) Availability of Maintenance Units. During the initial buildup the Navy, Marines, and Air Force experienced no major problem in providing maintenance support for the forces they committed to Vietnam.[4] The Army on the other hand suffered from its force development policy.[5] The active Army force structure was designed to have only those maintenance units which would be necessary for deployed support during the initial stages of a conflict. As the need arose and as the committed combat force became larger, maintenance units in the Reserve would be activated to provide the needed support. With the decision not to call up the Reserves, it became necessary for the Army to activate numerous direct and general support maintenance units. In addition, the characteristic of the war which required forces to be scattered throughout the country required a much higher ratio of combat service support to combat forces than normally required, resulting in a reduced initial maintenance capability.[6] Chapter Four, Volume II, of the Joint Logistics Review Board Report depicts the number of maintenance units in the force structure by year and the number of units activated or deployed.

(3) Availability of Qualified Personnel. Although the Navy, Air Force, and Marine Corps experienced certain skill shortages during the same period of time, these shortages were scant in comparison to those experienced by the Army. Except for the Army, the Services were able to cut back their other forces throughout the world so that from 90 to 100 percent of qualified maintenance personnel for Vietnam were provided.[7] The Army was required to rapidly expand its training program in the critical skill areas, such as aviation maintenance, to provide filler personnel for the newly activated units. The Air Force, Navy, and Marine were able, for the most part, to provide experience on type equipments prior to the individual's movement overseas. The Army, however, did not have a sufficient continental United States (CONUS) base for the employment of military maintenance skills at the intermediate level. (This base was filled by Department of the Army civil service repairmen at the installations and by civilian

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[2] Department of Defense, Commander in Chief, Pacific, COMUSMACV, Report on the War in Vietnam, 1968.

[3] Ibid.

[4] Headquarters, United States Marine Corps, Maintenance Manpower Requirements, 4 November 1969; Headquarters, United States Air Force, Maintenance Manpower Requirements, 29 October 1969; United States Navy, Bureau of Naval Personnel, Maintenance Manpower Requirements, 17 October 1969; United States Army, Deputy Chief of Staff Personnel, Maintenance Manpower Requirements, 31 October 1969.

[5] Department of the Army, Army Staff, Special Operational Report Lessons Learned, 1 January—31 October 1965 (SECRET).

[6] Department of Defense, Commander in Chief, Pacific, Memorandum, subject: Shortfall in Availability of Logistic Units (U), 1966 (SECRET).

[7] Headquarters, United States Marine Corps, Maintenance Manpower Requirements, 4 November 1969; Headquarters, United States Air Force, Maintenance Manpower Requirements, 29 October 1969; United States Navy, Bureau of Naval Personnel, Maintenance Manpower Requirements, 17 October 1969; United States Army, Deputy Chief of Staff Personnel, Maintenance Manpower Requirements, 31 October 1969.

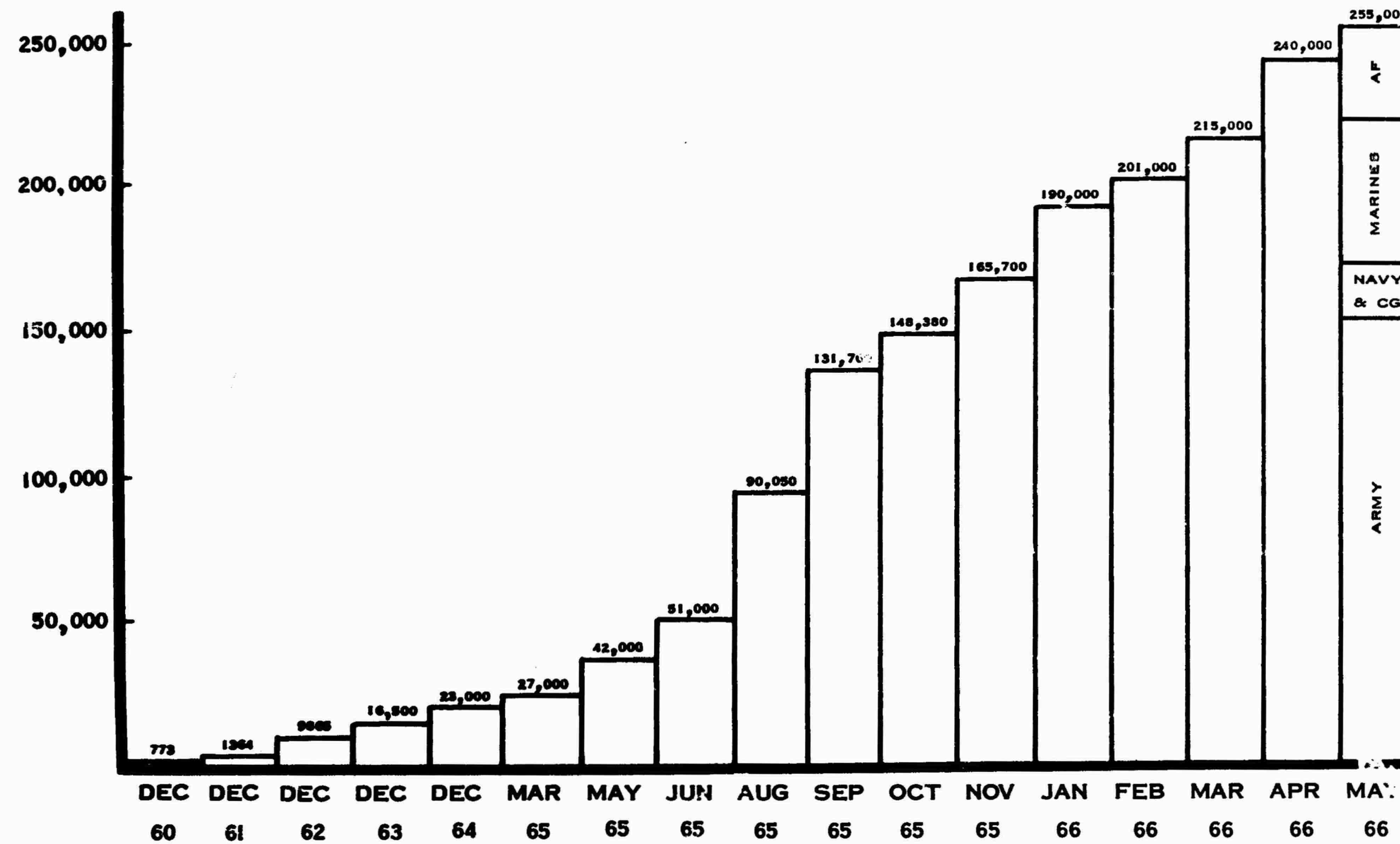

FIGURE 40. U.S. MILITARY BUILDUP IN VIETNAM 1960-1966

Source: Assistant Secretary of Defense Public Affairs.

contract maintenance in other instances.) Table 52 provides examples of the military and civilian mix at typical Army intermediate level maintenance activities. Table 53 provides a sampling of skill availability within the Army. The 1966 and 1969 worldwide and Vietnam requirements are shown for comparison purposes coupled with the yearly retention percentage.[8] Table 54 provides a sampling of additional skill availability and is intended to indicate the status of the skill in three major Army commands in addition to the worldwide status.

TABLE 52

SAMPLING OF ARMY PERSONNEL EMPLOYED IN INTERMEDIATE MAINTENANCE

	Authorized Aircraft Maintenance		Authorized Equipment Maintenance	
Location	Military	Civilian	Military	Civilian
Fort Benning, Georgia	15	29	35	384
Fort Bragg, North Carolina	4	34	24	460
Fort Carson, Colorado	4	9	11	195
Fort Riley, Kansas	9	9	25	178
Fort Hood, Texas	1	42	18	490

Source: Commanding General, CONARC, Message to JLRB, 16 February 1970.

(4) Training

(a) The training of maintenance personnel was considered adequate based on course objectives, and for this reason will only be discussed briefly.

(b) Each of the Services experienced problems because of the requirement to expand its training base. Messing facilities, housing facilities, classrooms, shop space, and instructors were all needed at one time or another in greater quantities than were available, but each of the Services has indicated that the training capability was not a limiting factor in providing qualified personnel. However, some training locations were operating at maximum capacity which means that had the Vietnam personnel requirement increased, a training shortfall would have been experienced for certain skills. Table 55 provides a sample of the increase in student output and the expansion of the training capacity that took place between 1965 and 1969. One important aspect of training is the impact that the requirement for instructors has on training and, concurrently, the availability of qualified maintenance supervisors for deployment overseas. The shortage of instructors and supervisors will become a very serious problem as the experienced personnel within the civilian and military work force retire in large numbers within the next decade.[9]

(c) At the beginning of the Vietnam buildup, each of the Services, in an effort to have its most experienced technicians in the field, drew on the upper enlisted grades. In the Air Force and Army, where the commitment of forces and the demand for technicians were large, the units remaining in the CONUS base, including training centers, experienced a shortage

[8] Department of the Army, Office of Personnel Operations, Enlisted Personnel Directorate, MOS Data Analysis Card, FY 1966 and FY 1969, 30 June 1969.

[9] Department of Defense, Office of the Assistant Secretary of Defense for Installations and Logistics, Report of the Long Range Logistics Manpower Policy Board, February 1969.

of well-qualified, noncommissioned officer supervisors and instructors.[10] This situation did not improve in some cases because the low retention rates in the technical skills prevented experienced individuals from remaining in CONUS for any length of time. Table 56 depicting the unbalanced situation which existed at one Army Technical Training Center provides a case in point.

TABLE 53

ARMY CRITICAL SKILL AVAILABILITY
(Percentage of Authorized Strength)

PMOS	Title	DA Retention Rate	Vietnam FY 66	Vietnam FY 69	Worldwide FY 66	Worldwide FY 69
13B4	Artillery Turret Mechanic	012.28	105	72	93	84
21H4	Guidance Control Repairman	050.00	--	--	95	49
21K4	Digital Computer Repairman	033.33	--	--	78	63
26C3	Radar Repairman	006.11	--	33	248	80
26M2	Airborne Radar Repairman	004.08	--	68	24	61
31E4	Field Radio Repairman	038.00	113	88	101	76
34G4	Fire Control Computer Repairman	040.00	--	--	21	16
35B3	Electrical Instrument Repairman	005.43	--	--	--	30
35B4	Electrical Instrument Repairman	034.78	--	--	--	76
45H2	Small Missile System Repairman	004.20	114	85	90	53
45Z4	Armament Maintenance Foreman	030.34	96	53	68	62
61C3	Marine Engine Repairman	001.49	31	16	26	36
61C4	Marine Engine Repairman	024.49	51	76	51	78
62B4	Engineer Equipment Repairman	037.37	112	88	85	81
63H2	Engine & Powertrain Repairman	007.26	105	84	120	91
63K4	QM Heavy Equipment Repairman	019.72	96	69	101	72
63Z5	QM Repair Supervisor	038.48	--	--	--	65
67W2	Helicopter Tech Inspector	040.33	89	41	95	76
68E2	Aircraft Electrical System and Instrument Inspector	005.80	90	68	79	77
68F2	Aircraft Electrician	005.21	80	80	94	93
68F3	Aircraft Electrician	003.61	--	73	54	79
68F4	Aircraft Electrician	028.57	--	--	--	67
68H2	Aircraft Hydraulic Repairman	002.70	86	89	93	86
67Z4	Helicopter Repair Foreman	005.17	--	--	--	03

Source: Department of the Army, Office of Personnel Operations, Enlisted Personnel Directorate, MOS Data Analysis Card, FY 66 and FY 69; Inventory and Projection of Army Strength, 30 June 1969.

[10] Headquarters, United States Marine Corps, Report: Maintenance Manpower Requirements, 4 November 1969; Headquarters, United States Air Force, Report: Maintenance Manpower Requirements, 29 October 1969; United States Navy, Bureau of Naval Personnel, Report: Maintenance Manpower Requirements, 17 October 1969; United States Army, Deputy Chief of Staff Personnel, Report: Maintenance Manpower Requirements, 31 October 1969.

TABLE 54

SELECTED MOS STATUS SUMMARY
(Percentage of Authorized Strength)

		Vietnam		CONARC		Europe		Worldwide	
PMOS	Title	FY 66	FY 69	FY 66	FY 69	FY 66	FY 69	FY 66	FY 69
23J20	Radar Repairman	54	--	128	--	68	--	80	--
23T4	Sgt Test Equipment Repairman	60	--	40	37	57	114	36	36
26C2	Surv Radar Repairman	50	92	84	64	86	67	73	73
31E2	Radio Repairman	95	99	81	91	81	111	82	95
68F4	Aircraft Electrician	--	--	--	52	--	31	--	64
44K2	Marine Hull Repairman	06	98	06	130	--	--	08	125
44K3	Marine Hull Repairman	1,600	--	04	--	--	--	53	--
63K2	QM Hvy Equipment Repairman	55	107	41	124	116	125	53	110
65B2	Locomotive Repairman	40	200	50	33	33	00	47	52
67F2	Acft Tech Inspector	79	77	102	182	84	168	87	125
67T3	ME SR Helicopter Repairman	42	02	67	--	25	03	48	05
67T4	ME SR Helicopter Repairman	31	107	71	54	--	300	64	90
68B4	Turbin Engine Repairman	33	211	42	61	86	63	55	77
68G2	Airframe Repairman	86	97	96	142	89	112	89	103

Source: Department of the Army, Office of Personnel Operations, Enlisted Personnel Directorate, MOS Data Analysis Card, FY 66 and FY 69, 30 June 1969.

TABLE 55

MAINTENANCE TRAINING—ANNUAL STUDENT LOAD

	ARMY	NAVY
Fiscal Year	Intermediate Aviation and Marine Maintenance	Organizational Total Maintenance
1965	5,882	55,000
1966	14,912	--
1967	28,960	65,000
1968	18,979	--
1969	38,878	105,000
1970 (projected)	34,640	

Source: U.S. Army Transportation School, June 1969; Bureau of Naval Personnel, October 1969.

TABLE 56

ARMY INTERMEDIATE LEVEL
AVIATION MAINTENANCE TRAINING—INSTRUCTOR SUMMARY

	FY 68		FY 69	
Category	On Hand	Authorized	On Hand	Authorized
Officer	146	224	203	270
Warrant	188	235	256	302
Enlisted	744	1,465	1,898	2,025
Civilian	286	233	251	260
Total	1,364	2,157	2,588	2,857

Instructor Grade Breakout as of 15 August 1969 (FY 70)

Status	COL	LTC	MAJ	CPT	LT	WO	E9	E8	E7	E6	E5 & Below
Authorized	1	9	46	85	5	191	7	54	499	930	20
AGSD	1	13	25	52	45	213	6	30	186	479	816
Over (+) Short (-)	0	+4	-21	-33	+40*	+22*	-1	-24	-313	-451	+796

*Not maintenance qualified.

Source: U.S. Army Transportation School, June 1969.

(d) Two alternatives were possible during Vietnam with regard to the maintenance and training capability. Either the quality of work of maintenance units in Vietnam suffered because of a lack of qualified supervisors, or the quality of instruction of trainees was diluted because of a lack of experienced instructors. The word "diluted" in this case should not be construed to mean that the training provided was unsatisfactory. On the contrary, the training centers did a commendable job with the talent available. However, for the future, the problem must be dealt with in the interest of efficiency and readiness.

(5) Effects of the 1-Year Rotation Policy

(a) Each of the Services at one time or another experienced personnel turbulence as a result of the 1-year rotation policy. Combat damage repair requiring highly skilled personnel has been a particular problem due to the 1-year rotational policy in effect for Vietnam. Academic school training with limited practical application does not qualify an individual to fully cope with the complex repair jobs immediately encountered in a combat environment. An individual joining a unit experiences a period during which he does not function at maximum effectiveness, depending upon the complexity of the job assignment, differences in operating procedures, and the type equipment with which he has to work. Not only is his effectiveness reduced, but also that of his coworkers and supervisors, who lose time in orienting and training the new arrival.

(b) Another facet of the 1-year tour has been the increased personnel pipeline requirement. The Air Force, for example, as of 30 June 1969 had over 19,000 personnel beyond the SE Asia authorization in the pipeline to satisfy the SE Asia requirement.[11] These personnel

[11] Headquarters, United States Air Force, Maintenance Manpower Requirements, 29 October 1969.

were pulled from CONUS, Europe, and other non-SE Asia areas to ensure a near 100 percent manning posture in SE Asia. Further, the training and familiarization of an individual with the equipment on which he will be working has increased the normal pipeline time requirement. Familiarization and cross-training requirements have been expanded in the past 2 years in order to preclude second and third SE Asia tours in critical skills.

(c) Army problems associated with the 12-month tour were similar to those experienced by the Air Force, but also were affected by several other factors related to the 2-year inductee.[12] Table 56 indicates Army maintenance skills in short supply for FY 69. Long training time (over 20 weeks duration), coupled with low retention rates and increasing authorizations, required an increase in personnel in the pipeline and the return of personnel with skills such as Engineer Equipment Repairmen and Helicopter Repair Foreman for second and third involuntary tours.

2. SPECIAL SUBJECTS

a. Skill Shortages

(1) General

(a) The importance of retaining skills which have been in continuous short supply cannot be over emphasized. Every year millions of dollars are spent on the recruitment, transportation, and initial training of thousands of technicians who leave the Services at the end of their obligated service. Subsequently, the cycle repeats itself for thousands of others who are also likely to follow their predecessors into civilian life. It is quite obvious that a newly trained recruit is not the equal of the man with 3 or more years experience whom he replaces.

(b) Skill shortages throughout the military services have been limited for the most part to those hard skills which require an extended training lead time and a period of on-the-job training before the desired proficiency is attained.

(c) The shortages that were experienced during the Vietnam era are those shortages which are generally troublesome during all contingency periods and which involve skills which experienced the lowest retention rates.

(d) Skill shortages are presented by Service to show the type of positions which must be provided in the rotational base to reduce the impact of a shortfall during a logistics buildup.

(2) Army. The Army problem is of significant proportions when compared to the other Services because of the predominance of the 2-year inductee in the ranks. Table 57 indicates the skill shortages experienced by the Army for FY 69. More specifically, Table 58 indicates Army aviation skill shortages experienced by the 34th General Support Group in Vietnam. A portion of the MOSs listed has a high short-tour authorization, which results in an increased input to Army training centers and formal schools to fill Vietnam requisitions. The rotational base is incapable of absorbing all of the returning personnel in the subject MOSs, causing a significant number to be retrained in other or related career fields. Subsequently, original primary MOSs are redesignated as secondary MOSs, and an overtraining condition exists in order to meet the continuing commitment to Southeast Asia. (Tables 53 and 54 also provide substantiating examples of the skill availability and related retention rates of the Army.)

[12] Department of the Army, Deputy Chief of Staff Personnel, Maintenance Manpower Requirements, 31 October 1969.

TABLE 57

ARMY MAINTENANCE SKILLS IN SHORT SUPPLY*

MOS	Retention Rate FY 69	Title
23Q	9.41	HAWK Fire Control Repairman**
25H	28.57	Radar Data Processing Equipment Repairman
26C	6.94	Ground Surveillance Radar Repairman
26D	13.24	Ground Control Radar Repairman
26M	5.00	Airborne Surveillance Radar Repairman
26N	unk	Surveillance Infrared Repairman
31E	13.89	Field Radio Repairman
31L	10.47	Field Radio Relay Equipment Repairman
31S	9.04	Field General COMSEC Repairman
34G	7.61	Fire Control Computer Repairman
35B	8.95	Electrical Instrument Repairman**
35K	5.90	Avionics Mechanic
35L	5.26	Avionic Communications Equipment Repairman
35M	3.59	Avionic Navigation Equipment Repairman
35P		Avionics Maintenance Supervisor**
41C	13.73	Fire Control Instrument Repairman
44B	6.63	Metal Body Repairman
44K	6.74	Marine Hull Repairman
45C	11.81	Field Artillery Repairman
45J	9.80	Aircraft Armament Repairman
45Z	60.78	Armament Maintenance Foreman**
54D	8.47	Chemical Equipment Repairman
62B	15.15	Engineer Equipment Repairman/Supervisor
63B	unk	Wheel Vehicle Repairman
63C	15.78	General Vehicle Repairman
63F	unk	Recovery Specialist**
63G	9.24	Fuel and Electrical Systems Repairman
63H	14.15	Engine and Powertrain Repairman
63J	24.49	Quartermaster Light Equipment Repairman**
63K	13.72	Quartermaster Heavy Equipment Repairman
63Z	unk	Mechanical Maintenance Supervisor**
65B	.00	Steam Locomotive Repairman**
67F	54.84	Airplane Technical Inspector
67T	unk	CH-37 Helicopter Repairman
67W	53.00	Helicopter Technical Inspector
67X	11.68	CH-34 Helicopter Repairman
67Z	5.17	Aircraft Maintenance Supervisor**
68B	7.32	Aircraft Engine Repairman
68C	8.93	Aircraft Reciprocating Engine Repairman
68D	6.43	Aircraft Powertrain Repairman
68E	8.25	Aircraft Rotor and Prop Repairman
68F	6.49	Aircraft Electrician**
68F	28.57	Aircraft Electrician Supervisor
68G	4.80	Airframe Repairman
68H	3.90	Aircraft Hydraulics Repairman
76R	10.24	Missile Repair Parts Specialist
76S	9.12	Automotive Repair Parts Specialist
76T	12.43	Aircraft Repair Parts Specialist

*The term "shortage" is applicable when the ration of sustaining-base to short-tour is less than 2.1:1 (SB : ST less than 2.1:1) except in those MOS indicated by footnote 2.

**Shortage based on actual strength of less than 95 percent (95% to 105% is considered to be a balance status).

Source: Department of the Army, Deputy Chief of Staff Personnel, Maintenance Manpower Requirements, October 1969.

TABLE 58

ARMY, 34TH GENERAL SUPPORT GROUP
CRITICAL MAINTENANCE SKILL SHORTAGES
(As of July 1969)

MOS	HHC	AMMC	110th	241st	14th	58th	520th	765th	Totals	%
35M20	0/1	0/0	0/0	0/0	43/35	8/9	4/5	47/23	102/73	71.5
45J20	0/0	1/3	0/0	0/0	30/26	17/16	31/30	42/33	121/108	89.2
45J40	2/2	1/0	1/0	1/0	5/4	2/1	4/2	6/7	22/16	72.7
63C40	1/1	0/0	1/2	1/0	6/5	3/1	6/7	7/4	25/20	80.0
67F20	0/1	0/1	0/0	0/0	10/10	5/6	12/9	13/11	40/38	95.0
67F40	3/2	2/1	0/0	0/0	1/1	2/2	1/1	1/2	10/9	90.0
67R20	0/0	0/0	0/0	0/0	3/3	3/5	0/3	42/18	48/29	60.4
67V20	0/0	0/0	0/0	0/0	20/8	15/7	25/8	0/13	60/36	60.0
67W20	0/0	0/2	2/1	2/2	30/16	11/6	29/15	22/17	96/59	68.6
67W40	4/2	2/0	0/1	0/0	3/2	2/2	3/3	3/5	17/15	88.2
67Y20	0/0	0/0	0/0	0/0	7/6	0/2	24/4	0/0	31/12	38.7
68D20	0/0	0/0	0/0	0/0	14/12	10/3	14/13	22/26	60/54	90.0
68E20	0/0	0/0	0/0	0/0	14/8	10/7	14/9	25/22	63/46	73.0
68F30	0/0	0/0	0/0	0/0	8/0	4/5	4/4	17/4	33/13	39.3
68H20	0/0	0/0	0/0	0/0	17/7	11/7	17/17	28/17	73/48	65.7
Total	10/9	6/7	4/4	4/2	211/143	103/79	188/130	275/202	801/576	72.8

Authorized/Assigned

Source: U.S. Army, Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Reviews and Analysis of U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

(3) Navy

(a) Shortages of skilled maintenance personnel (petty officers) have generally existed in surface electronics, ordnance, engineering, and aviation electronics ratings in which there have been significant increases in requirements. Table 59 depicts the skill shortages experienced by the Navy, the ability to man these positions, and the FY 69 retention rates. Table 60 depicts the type of skills (rates which were short from FY 65 through FY 69.

(b) During the period of the Vietnam buildup, the Navy experienced a problem of quality (upper pay grade) increases and end strength. The major problem in providing sufficient numbers of skilled personnel to Vietnam was one of balancing fleet stability, Vietnam requirements, and Vietnam veterans guarantees provided in accordance with reenlistment policies. Vietnam requirements were at times filled at the expense of fleet stability because of the number of Vietnam veterans within specific ratings and the desire not to return them for a second tour. Skilled repairmen were withdrawn from CONUS and the Atlantic and Pacific Fleets, reducing their manning resources to 50 percent of authorized levels in some skill areas. Hardest hit were the CONUS and Atlantic Fleets because they were not in direct support of Vietnam.

TABLE 59

NAVY MAINTENANCE SKILLS IN SHORT SUPPLY
(FY 69)

Rate	NEC	Percent Manned	Title
RD	0334	22.4	Electronic Warfare Operator
RD	0335	18.2	Electronic Warfare Systems Spec
ST	0451	74.8	Surface Sonar Technician
ST	0455	65.8	Surface Sonar Technician
ET	1159	72.5	Missile Weapons Control Sys Tech
ET	1541	63.9	Security Device Equip Tech KY8
ET	1542	58.1	Security Device Equip Tech K614
ET	1549	57.6	Security Device Equip Tech KW3TT
ET	1577	68.5	Ground Controlled Approach Tech
ET	1591	62.1	Electronic Warfare Systems Tech
RM	2314	72.2	Cryptographic Machine Repairman
RM	2319	59.4	Commo Sys Technical Supervisor
RM	2333	64.1	Radio Equip Maintenanceman
RM	2344	66.9	Teletype Repairman
RM	2372	51.1	Commo Sys Technician
	3332	73.5	NAVDAC Technician
IC	4724	52.4	Electrical Gyrocompass Tech
IC	4746	64.8	Closed Circuit TV Tech
AD	6422	64.7	Jet Test Cell Operator
AT	6622	54.5	Calibration Specialist
AT	6625	42.4	Airborne TDWS Tech
AT	6634	73.7	TACAN Maintenance Tech
AT	6655	54.6	Automated Checkout Equip Tech
AB	7015	28.1	Arresting Gear Maintenanceman
AE	7103	35.7	Automatic FLT Ref System Tech A4E
AE	7105	25.2	Automatic FLT Ref System Tech A7A
AE	7133	60.4	Automatic FLT Control Tech F4B
AE	7134	55.9	Automatic FLT Control Tech F8
AG	7423	65.7	Computer Operator
TD	7513	40.9	CIT Devices Technician
TD	7523	9.8	OF/WST Technician
AQ	7948	65.4	Bomb Director Set Technician
AQ	7961	37.6	Ballistics Computer Set Tech
	8287	48.3	ECM Operator
	9558	41.4	Beach Jumper Unit Tech

Source: Department of the Navy, Bureau of Naval Personnel, Maintenance Manpower Requirements, 17 October 1969.

TABLE 60

NAVY MAINTENANCE SKILLS

FY	Authorized Maintenance Skills	Assets of Maintenance Skills	Critical Skill Shortages (90% or less E4-E9 manning)
1965	194,480	179,322 (92.2%)	ST, AX, ET, EN
1966	209,779	186,047 (88.7%)	ST, DS, EN, AE, GM, ET, IC, AT, MN, TM, AB, AQ, AN
1967	209,779	188,411 (87.1%)	ST, MM, AT, GM, EM, AD, TM, EN, AQ, DS, IC, AM, AB, AS
1968	223,101	209,580 (93.9%)	DS, IM, AT, CT, IM, AQ
1969	215,507	216,723 (100.5%)	IM

Key:

AB - Aviation Boatswains Mate
AD - Aviation Machinists Mate
AE - Aviation Electricians Mate
AM - Aviation Structural Mechanic
AN - Aviation Nonrated
AQ - Aviation Fire Control Technician
AS - Aircraft System Maintenance Tech
AT - Aviation Electronics Technician
AX - Aviation Antisubmarine Warfare Tech
CT - Communications Tech
DS - Data Systems Tech
EM - Electricians Mate
EN - Engineman
ET - Electronics Tech
GM - Gunners Mate
IC - Interior Communications Electrician
IM - Instrument Man
MM - Machinists Mate
MN - Mineman
ST - Sonar Technician
TM - Torpedoman Mate

Source: Department of the Navy, Bureau of Naval Personnel, Maintenance Manpower Requirements, 17 October 1969.

(4) Marine Corps. The Marine Corps experienced very few skill shortages. From a quantitative standpoint, Vietnam requirements for the majority of maintenance skills posed no particular staffing problem that was not solved by rank and MOS substitutions, the use of civilians, or the use of contract field service personnel. Table 61 depicts the particular maintenance skills which have been in continuing short supply in the Marine Corps. Table 62 depicts Marine Corps critical shortages on a worldwide basis.

(5) Air Force. The Air Force experienced very few acute skill shortages both quantitatively and qualitatively in meeting their SE Asia requirements. The initial requirement that all Air Force maintenance personnel being sent to SE Asia were to be skilled (5 skill level or above) caused an initial imbalance of skill levels in non-SE Asia areas. This requirement, established based on the mission requirements and available resources at the outset of the SE Asia action, resulted in a general decrease in the non-SE Asia maintenance capability due to the need for a substantial increase in training and supervision. When SE Asia tours were opened to 3 level (semi-skilled) airmen, a better balance of skills was effected, but the resultant shortage of skilled airmen caused by the increased pipeline time and the requirement for cross-training and equipment familiarization still affected the overall maintenance capability. Table 63 depicts those Air Force skills which were manned below the acceptable level for FY 69.

b. Retention

(1) The one major personnel problem in the Department of Defense today for which there is no immediate solution in sight is that of retention, or more precisely, the inability to retain adequate numbers of skilled, trained personnel to maintain the complex hardware currently employed by United States forces at the optimum standard of readiness for war.

TABLE 61

MARINE CORPS MAINTENANCE SKILLS IN SHORT SUPPLY

MOS	Title	Authorized	Assigned
2149	Tracked Vehicle Technician	--	--
2151	Turret Repairman	199	64
2157	Hawk Mechanical System Repairman	42	6
2812	Cryptographic Equipment Technician	65	26
2831	Radio Relay Repairman	698	759
2861	Radio Technician	703	401
2867	DY-8 Radio Technician	130	57
2871	Electronic Instrument Repairman	8	1
2872	Electronic Calibration Technician	44	37
2873	Mechanical Calibration Technician	10	0
5977	Tactical General Purpose Computer Repairman	51	41
5979	Tactical Data Systems Technician	125	98
5981	Digital Data Systems Technician	38	24
5991	Electronics Maintenance Chief	9	0
5992	Ground Radar Maintenance Chief	2	0
5994	Tactical Data Systems Maintenance Chief	1	0
6251	Avionics Test Equipment Calibration/Repairman	220	147
6293	Avionics Test Equipment Calibration Chief	3	0
6315	VG Jet Aircraft Flight Engineer	78	60
6323	Aircraft Jet Engine Mechanic	219	170
6379	Aircraft Maintenance Support Equipment Chief	15	2
6395	Aviation Maintenance Support Equipment Chief	1	0

Source: Headquarters, U.S. Marine Corps, Maintenance Manpower Requirements, 4 November 1969; Enlisted Personnel Availability Digest, November 1969.

TABLE 62

MARINE CORPS MAINTENANCE SKILLS SHORT WORLDWIDE

MOS	Description	Chargeable Personnel	Billets to be Filled	USMC Available Percent (%)
2831	Radio Relay Repairman	512	627	81.6
2861	Radio Technician	358	646	55.4
2867	KY-8 Radio Technician	31	92	33.6
5977	Tactical General Purpose Computer Repairman	39	92	42.3
5979	Tactical Data Systems Technician	90	129	69.7
6251	Avionics Test Equip Calibration Repairman	110	198	55.5
6323	Aircraft Jet Engine Mechanic T-76	134	173	77.4

Source: Headquarters, U.S. Marine Corps, Maintenance Manpower Requirements, 4 November 1969.

TABLE 63

AIR FORCE MAINTENANCE SKILLS IN SHORT SUPPLY

AFSC	Retention Rate FY 69	Title	Percent Manned
301X0	19.2	Aircraft Radio Repairman	90 (since July 1968)
303X1	12.7	Air Traffic Control Radar Repairman	90 (since July 1969)
303XX	21.2	Radar Repairman	
303X0			80 (since December 1968)
303X1			90 (since April 1968)
305X1	21.5	Electronic Digital Data Processing Repairman	90 (since June 1967) 103 (July 1969)
30XXX	21.6	Communications - Electronics System Specialist	98 (since December 1968)
325X0	21.9	Automatic Flight Control System Specialist	90 (since June 1967)
421X1X	9.5	Aircraft Propeller Repairman (Reciprocating Engine & Turbo Prop)	
421X1A			90 (August 1967 - March 1969) & 115 (April 1969)
421X1B			85-90 (October 1967)
421X2	10.9	Aircraft Pneudraulic Repairman	90 (since July 1967)
424X0	10.7	Aircraft Fuel Systems Mechanic	85-90 (since June 1967)
431X0X	17.6	Helicopter Mechanic	85 (since September 1967) under 100 (July-December 1968) above 100 (February-July 1969)
534X0	7.1	Airframe Repair Specialist	85-90 (since January 1968)

Source: Headquarters, United States Air Force, Maintenance Manpower Requirements, 29 October 1969.

(2) Key, trained, technical personnel leave the Armed Forces in unacceptable numbers, diluting the return on the investment. The cost of training Army aviation mechanics provides a good example.[13] An aircraft electrician who costs $5,106.06 in FY 67 is estimated at $5,871.97 in FY 70. Increase the aircraft electrician cost by the FY 70 student input of 462 and apply the Department of the Army retention rate of 5.21, and theoretically an investment worth $2.5 million will have been depreciated to a zero value in 2 years (tour length inductees).[14] From testimony, *ad infinitum*, in the public record about the inability to retain the required

[13]Department of the Army, U.S. Army Transportation School, Training Cost Per Course, August 1969.
[14]Department of the Army, U.S. Army Transportation School, Schedule of Classes FY 70, 1 July 1969.

trained personnel, one must conclude that United States organic military maintenance capability taken as a whole, is at other than optimum readiness.[15]

c. Maintenance Rotational Base

(1) The single, solvable problem which evolves from a study of the maintenance manpower problems of the Vietnam era is the need to establish an appropriate mix of military and civilian maintenance personnel in CONUS as a military rotational base.

(2) The minimum wartime availability of skilled, experienced military maintenance personnel at the intermediate (Army) and depot (all Services) level can be traced to the maintenance rotational base at these levels in CONUS. Coupled with this minimum availability of skilled military maintenance personnel is the manning of civilians in the actual hard skill duty positions, a fact which is easily misrepresented by the current figures regarding the military and civilian mix in each Service:

	Army	Navy	Marine Corps	Air Force
Military	829	619	419	726
Civilian	21,185	130,407	1,572	48,167

The Army figure includes 637 military personnel assigned to the Floating Aircraft Maintenance Facility. The Navy represents estimated military managers assigned to depot shipyard and Air Rework Facilities.

(3) In order to understand how the present maintenance rotational base evolved, it is necessary to understand the derivation of the methodology behind the military-civilian mix concept. Initial substantiation for the use of civilians and contractors in the CONUS base dates back to a World War II War Department Circular (Number 248), dated August 1945, which stated in effect that military personnel should be trained in purely military duties. Various commissions, congressional committees, and Department of Defense directives have also advocated the use of civilians where military personnel are not required for "reasons of law, training, security, discipline, rotation or combat readiness."[16]

(4) The Services generally agree on the criteria used in designating a position as military or civilian and have made provisions for rotation base requirements in the force structure authorizations.[17] The accepted doctrine has been that the military will do the fighting while civilians will be used for support and continuity in areas not involving combat. To provide military skills for logistics support in the combat theater, it was planned that reserve forces be called to active duty. This call-to-duty did not occur; the CONUS rotational base was not equipped to handle the task in all cases. Therefore, logistics operations in the forward areas resorted to the use of United States civilian, local national, and contractor personnel.

(5) The Services are continuously evaluating and adjusting the military and civilian mix in the CONUS base, and with the exception of the Army, appear to have had an acceptable intermediate level mix based on their Vietnam commitments. The military and civilian mix at the depot level has been predominately civilian but has not had an effect on maintenance in Vietnam, since depot repairs have been retrograded or placed on offshore contracts. It should be noted that any future decision to organically accomplish depot level maintenance in a combat theater will evidence a lack of organic military capability in this area.

[15] Newspaper Article, $120 Million in Bonuses Fail to Bolster Military Retention, The Washington Post, 18 December 1969.
[16] Department of Defense Directive 1100-4, Guidance for Manpower Programs, 20 August 1954.
[17] Department of the Ar… Deputy Chief of Staff Logistics, Summary Sheet, Evaluation of Adequacy of CONUS Base in Support of Overseas Deployment of Aviation Personnel (U), 22 June 1964 (CONFIDENTIAL).

(6) The Army rotational base problem stems from the predominantly civilian maintenance operation at the intermediate level in CONUS. The most positive effect of the civilianization of the CONUS maintenance operation is found in the Army experience in Vietnam where the Army was unable to organically maintain its equipment without extensive contractor support.[18]

(7) An example of the need for an adequate rotational base can be found in the case of Army aircraft maintenance. The requirement to establish a rotational base for aviation mechanics was recognized prior to the buildup in Vietnam in 1965. An evaluation was conducted by an ad hoc group of the Army staff to evaluate the adequacy of the CONUS base in support of the overseas deployment of aviation personnel, since the Army was deeply involved in helicopter operations in Vietnam at this time. The evaluation was conducted at the time the Army was being criticized for contracting aircraft maintenance while military personnel with aviation maintenance MOSs were assigned in nonaviation-related duties.[19] The evaluation indicated that there was a shortage of several thousand military MOS spaces in the CONUS rotational base to support overseas deployments. It also indicated that contract aircraft maintenance employed a comparable number of personnel, the majority of whom were doing work that was compatible with the skill shortages in the operational base. Of the civil service personnel employed in aviation maintenance, it was found that approximately half of the spaces were also compatible with the skill shortages in the rotational base. The study was not implemented because of the effect it might have had on the expanding pilot training program.

(8) In 1966, based on several factors which threatened the contract aircraft maintenance program, the Department of the Army developed a follow-on plan for employing additional military maintenance personnel. This was deferred because of the possible impact on the pilot training program.[20]

(9) In January 1969, additional problems caused the reevaluation of the follow-on plan. The reevaluation disclosed that there was an increasing need for a maintenance rotational base for aviation mechanics. Accordingly, the follow-on plan was titled Rotational Base for Army Aviation Maintenance (ROBAM).

(10) The rapid buildup of Army aircraft and aircraft maintenance units in Vietnam found aviation maintenance manpower authorizations increasing in-country while at the same time being reduced in the CONUS base, with the result that a large number of aviation maintenance personnel were assigned to other than their Primary Military Occupational Specialty (PMOS) upon return to CONUS or other long tour areas.[21] The ROBAM plan indicated that there was a requirement for a large rotational base in the Army Force structure.[22] ROBAM is presently being staffed by the Department of the Army.

(11) Aviation maintenance is only one of a variety of hard-skill areas where an adequate military rotational base must be established by the Army at the intermediate maintenance level. Obviously, there are others based on the different types of equipment which were not maintained organically by the Army during the Vietnam era.

(12) The rotation base problem hinges on the military-civilian mix and the amount of maintenance that is placed on contract. The non-Fleet Marine Force mix of one military to one civilian is one answer, but is not necessarily suitable for mission accomplishment of the other Services.[23]

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[18] Department of Defense, Office of the Assistant Secretary of Defense for Installations and Logistics, Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

[19] Department of the Army, Staff Analysis, Rotational Base for Army Aviation Maintenance (ROBAM) (U), (CONFIDENTIAL).

[20] Department of the Army, Deputy Chief of Staff Personnel, Memorandum, subject: RECAM (U), 4 November 1968 (CONFIDENTIAL).

[21] Ibid.

[22] Department of the Army, Staff Analysis, Rotational Base for Army Aviation Maintenance (ROBAM) (U), (CONFIDENTIAL).

[23] Headquarters, United States Marine Corps, subject: Logistics Manpower Briefing, 10 October 1968.

d. Civilianization

(1) General

(a) One of the apparent basic causes for the lack of experienced military skills in the maintenance manpower spectrum at the intermediate and depot levels had been the civilianization of the hard skills through either civilianization programs (1966) or employment of predominately civilian repairmen at these levels. The Air Force, Navy, and Marine Corps experienced civilianization at the depot levels, while the Army used civilians both at the intermediate and depot levels. The accepted policy appears to be that civilians will be used at the depot level, since this level will more than likely be performed in CONUS during wartime. However, experience in Vietnam indicates that quite often aircraft combat damage becomes a depot level repair for all Services and it is necessary to accomplish the repair in-country rather than return the item to CONUS.

(b) On the national level, the management of manpower involves numerous complex problems. The Federal government in addition to being concerned with the Nation's manpower is the country's largest single employer. In the latter role, the Government faces problems in manpower management the solution of which have a marked effect on the effective use of national manpower resources. Within the Federal Government, the Department of the Army with an end FY 69 strength of approximately 1.9 million is the largest employer of manpower.[24] The management of this large block of manpower presents many problems, one of which is the composition of the force—i.e., which tasks should be performed by military personnel and which should be performed by civilians.

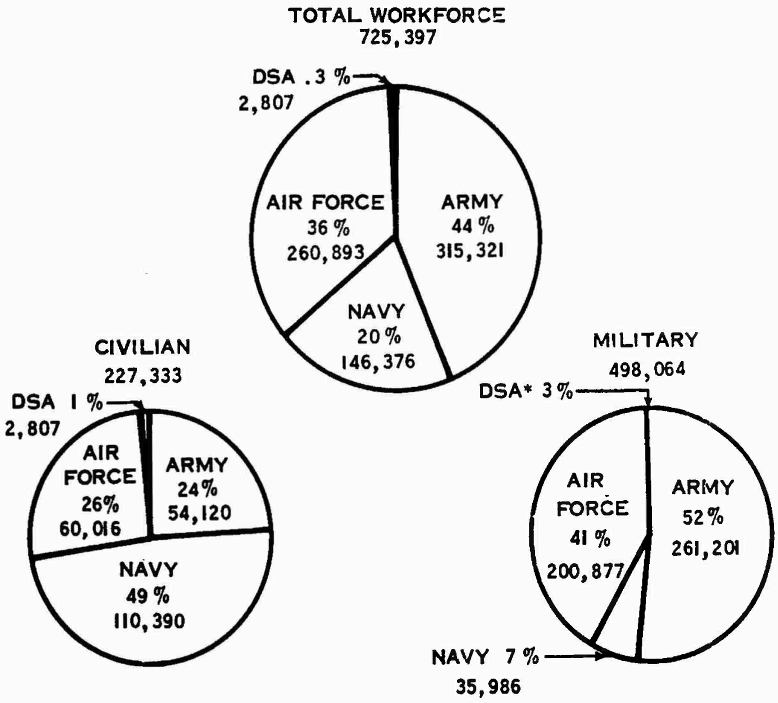
(c) Employment of large numbers of civilians in the overall Department of Defense maintenance work force becomes a very practical solution to the problem of maintaining technical expertise in an era of declining military retention rates. Civilian repairmen provide continuity plus a maintenance base that has the capability of providing on-the-job training to military personnel and units prior to deployment. The noteworthy problem that arises when CONUS activities are civilianized is that manpower ceilings prevent the existence of a duplicate body of military maintenance personnel who would be deployed in the event of war or a national emergency. Military maintenance personnel to fill wartime commitments have been acquired as the need has arisen; but with the degree of complexity experienced in our equipment currently, it would be advantageous to maintain an adequate military rotational base which would be available as a source of military maintenance manpower for future combat service support operations.

3. SIZE OF WORK FORCE

a. A discussion of the military-civilian mix within the Defense Maintenance Logistics work force must begin with an understanding of the size of the force and the current mix as it now exists. Figure 41 and Table 64 are breakouts of the mix by Service. The misleading item about these breakouts is that they correctly portray a predominantly military force in the maintenance function, but do not divulge the one major factor which affects the military maintenance manpower capability. The civilian work force, with the exception of the Marine Corps, is employed at the intermediate and depot levels while the military force is employed primarily at the organizational level.

b. The Services are totally different in their utilization of the civilian-military mix. Comparison of the two circles at the bottom of Figure 41 shows that the Navy Maintenance work force is roughly 3 to 1 civilian while the Army is 5 to 1 military and the Air Force 3 to 1 military. In all three Services the composition of this work force is essentially 90 percent civilian Wage Board or enlisted military.

[24] U.S. Congress, House of Representatives, Committee on Appropriations, Hearings, subject: Military Personnel, 90th Congress, Second Session, 1969, Part 5.



*DSA military included in service totals.

FIGURE 41. DEFENSE MAINTENANCE FUNCTION BY SERVICE

JLRB Note: The Navy organizational and intermediate level operating personnel responsible for maintenance of the equipment they operated aboard ship are not included in the Navy military manpower figure. Inclusion would of course increase the military to civilian ratio.

Source: Department of Defense, Office of the Assistant Secretary of Defense, Installations and Logistics, Report of the Long Range Logistics Manpower Policy Board, February 1969.

. MILITARY DEPARTMENTS' ANNUAL MANPOWER REQUIREMENTS

a. The annual process of determining overall manpower requirements commences as the military services calculate their total requirements by summing up the totals of the individual operating units, supporting elements, bases, posts, and stations. The existing situation at any one installation in terms of civilian and military spaces is reviewed, and modifications are normally applied. Seldom are large changes in the civilian-military mix recommended.

b. Generally speaking, civilian spaces, once established, are rather difficult to convert or delete. Should a base commander recommend reduction of a civilian space, there is no guarantee of an automatic compensating increase in military strength. It appears that this type of situation exists throughout the Department of Defense—a situation which has perpetuated itself over the years, correctable only by manpower management and policy determinations at the highest levels.

TABLE 64

DEPARTMENT OF DEFENSE LOGISTICS WORK FORCE
MAINTENANCE FUNCTIONAL AREA
(BY SERVICE)

	Army			Navy			Air Force			DSA*			Total		
Category of Personnel	No.	% of Total Army	% of Total DOD	No.	% of Total Navy	% of Total DOD	No.	% of Total AF	% of Total DOD	No.	% of Total DSA	% of Total DOD	No.	% Total All Services	% Total DOD
Civilian Wage Board	48,844	15	23	106,618	73	50	55,947	21	26	2,045	73	1	213,454	29	100
Civilian Class Act	5,276	2	38	3,772	3	27	4,069	2	29	762	27	6	13,879	2	100
Civilian Total	54,120	17	24	110,390	76	49	60,016	23	26	2,807	100	1	227,333	31	100
Military Enlisted	252,336	80	53	32,528	22	7	192,913	74	40				477,777	66	100
Military Officers	8,865	3	44	3,458	2	17	7,964	3	39				20,287	3	100
Military Total	261,202	83	53	35,986	24	7	200,877	77	40				498,064	69	100
Total Work Force	315,321	100	44	146,376	100	20	260,893	100	36	2,807	100		725,397	100	100

*DSA military included in Service totals.

Note: Personnel are given as a percent of the Service total (when added vertically) and a percent of the DOD total (when added horizontally).

Source: Department of Defense, Office of the Assistant Secretary of Defense (Installations and Logistics), Report of the Long Range Logistics Manpower Policy Board, February 1969.

5. DOD MANPOWER POLICY

a. Although published in 1954, the general manpower policy of the Department of Defense, Directive 1100-4,[25] still remains effective today and has a direct bearing on current Service department policies. The directive states that manpower requirements are to be programmed by the Services at the minimum level necessary to achieve vital objectives, with first priority assigned to major combat forces. Civilian requirements are to be determined on the basis of planning and workload factors with strengths maintained at the minimum level necessary to accomplish the required tasks. In areas which require both military and civilian personnel, manpower requirements are to be determined as a total while maximum stability of personnel is to be maintained consistent with training, readiness, and morale requirements. A high ratio of operating Forces to total Force is to be maintained and emphasis placed on reducing support type positions in the operating force.

b. The directive also contains an important paragraph on the utilization of civilian personnel:

> "Civilian personnel will be used in positions which do not require military incumbents for reasons of law, training, security, discipline, rotation, or combat readiness, which do not require a military background for successful performance of the duties involved, and which do not entail unusual hours not normally associated or compatible with civilian employment."

However, several questions arise, particularly with respect to civilian personnel. The stipulation that "civilian personnel will be used in positions which do not require military incumbents for reasons of..." appears to ensure the use of military personnel wherever needed and assumes that each manager will make the correct choice when designating a position as military or civilian.

6. ARMY CIVILIANIZATION AT INTERMEDIATE LEVEL OF MAINTENANCE

a. The Army is the only military service which has almost totally civilianized its intermediate level installation maintenance in CONUS. Field maintenance shops operate under a consolidated maintenance and supply concept at most installations and perform both direct and general support maintenance for customer units. Table 65 depicts the military-civilian mix at selected Army installations throughout the CONUS. The use of civilian repairmen rather than military repairmen is considered desirable for several reasons:

(1) Civilians provide continuity and offset the turbulence produced by military transfers and discharges.

(2) Civilian repairmen are able to devote full time to their jobs whereas military repairmen must devote at least a part of the workday to traditional military duties.

(3) Civilians maintain a degree of technical competence which is not found in the 2-year draftee.

b. The use of predominately civilian repairmen at the intermediate level in CONUS has eliminated a number of military positions which are required for the CONUS rotation base. These positions would normally be used to provide on-the-job training prior to an overseas assignment as well as a place of employment for the military repairmen upon his return from overseas. The lack of sufficient military positions in the CONUS base has forced the Army to retrain individuals or make assignments to a secondary military occupational specialty. Table 65 depicts the military spaces authorized worldwide in the CONUS for those military occupational specialties considered critical.

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[25] Department of Defense, DOD Directive 1100-4, Guidance for Manpower Programs, 20 August 1954.

TABLE 65

ARMY PERSONNEL SPACE AUTHORIZATIONS
(As of June 1969)

Title	MOS	Worldwide	CONUS
Ground Surveillance Radar Repairman	26C	195	88
Airborne Surveillance Radar Repairman	26M	208	112
Field Radio Repairman	31E	774	553
Electrical Instrument Repairman	35B	326	114
Avionics Mechanic	35K	740	155
Avionics Commo Equip Repairman	35L	580	146
Avionics Navigation Equip Repairman	35M	483	107
Aircraft Armament Repair	45J	1058	269
Armament Maintenance Foreman	45Z	431	143
Marine Engineer	61C	608	190
Engineer Equipment Repairman	62L	3683	1057
General Vehicle Repairman	63C	12720	4868
Fuel & Electrical Systems Repairman	63G	880	195
Engine & Powertrain Repairman	63H	5872	1054
Quartermaster Light Equipment Repairman	63J	235	55
Quartermaster Heavy Equipment Repairman	63K	781	222
Airplane Technical Inspector	67F	315	130
Helicopter Technical Inspector	67W	1343	430
Aircraft Engine Repairman	68B	1132	264
Aircraft Powertrain Repairman	68D	401	104
Aircraft Rotor & Prop Repairman	68E	599	109
Aircraft Electrician	68F	602	148
Aircraft Repairman	68G	1437	274
Aircraft Hydraulics Repairman	68H	370	107
Aircraft Repair Parts Specialist	76J	1111	255
Automotive Repair Parts Specialist	76S	2663	718
Communications Repair Parts Specialist	76U	1638	887

Source: Department of the Army, Office of Personnel Operations, Enlisted Personnel Directorate, MOS Data Analysis Card FY 1966 and FY 1969, 30 June 1969.

7. CIVILIANIZATION AT DEPOT LEVEL OF MAINTENANCE

a. The military services are required by DOD Directive 4151.1 to develop an organic depot level maintenance capability to maintain mission-essential materiel.[26] The majority of depot level work performed by Department of Defense employees is accomplished in the depot facilities of each of the Services located in CONUS. Depot maintenance is normally programmed for accomplishment during peace or war at facilities that are not subject to direct attack; therefore, the use of civilians has been considered advantageous. Very few military personnel are

[26] Department of Defense, DOD Directive 4151.1, Policies Governing the Use of Commercial and Military Resources for Maintenance of Military Materiel, 28 July 1960.

assigned to depot maintenance; those assigned are normally not directly engaged at the repairman level.

b. In Vietnam the Services discovered that battle-damaged new equipment required depot level repairs which were more feasibly accomplished in-country rather than in CONUS. In the absence of depot level qualified military repairmen assigned in-country, several alternatives were possible: Special teams from CONUS depots could be provided to the overseas command, i.e., Air Force RAM teams; qualified repairmen could be contracted, i.e., Army contracts with Lear Sigler, Dynelectron, and Lockheed; or manufacturers' technical representatives could be provided to advise military repairmen.

c. Vietnam experience indicates that future wars with a similar extended pipeline may require depot level maintenance in the war zone. Assuming this to be true, the military-civilian mix at the depot level should be adjusted to include more military personnel with assignments to repairmen positions. The provision of military personnel in the war zone on a routine assignment would be more economical and practical than sending special teams on a per diem basis or paying for the cost of contractor talent.

8. CONTRACT MAINTENANCE

a. General

(1) Contract maintenance has been used in varying degrees since World War II to provide zone-of-interior and overseas-based backup support to the forces in the combat zone. In most cases, the type of maintenance provided was depot level with the equipment being Inspected and Repaired as Necessary (IRAN) or completely overhauled. Historically and legally, within the limits prescribed by the Department of Defense, the Services have avoided contracting strictly for maintenance. Maintenance services are defined as the provision of people (talent) by a contractor without the identification of work specifications by type equipment and specific numbers of equipment to be processed.

(2) Vietnam produced a situation where contractor personnel were attached to military units to augment the military capability in those areas where the type or extent of the repair required was beyond the capability of the military skills available.[27] Each of the Services found it necessary to use contract maintenance to provide support to its forces in SE Asia. Table 66 depicts the magnitude of SE Asia contract maintenance support.[28] The Army employed the highest number of contract personnel in the area of maintenance with the major portion working specifically in aircraft maintenance. The uniqueness of the contract maintenance for support of Army aircraft in Vietnam is discussed in paragraph 7 b.

(3) An examination of the force readiness posture indicates that the readiness rate of equipment in Vietnam was maintained at a very satisfactory level and that at least a part of the credit must be attributed to contractor support.[29] Additionally, because of the indigenous labor rate maintenance of equipment was accomplished more economically offshore than if it had been retrograded to CONUS.

(4) The principal reason behind the level of contract maintenance that was conducted in SE Asia (organizational, intermediate, and depot) and the number of contractor personnel involved, was found to be the military personnel problem.[30] Throughout the Vietnam era each of the Services was affected by the manpower ceilings. At one time or another, contracts

[27] Department of the Army, U.S. Army Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

[28] U.S. Congress, House of Representatives, Committee on Appropriations, Hearings, subject: Military Personnel, Ninetieth Congress, Second Session, 1969, Part 5.

[29] Department of Defense, Office of the Assistant Secretary of Defense, Installations and Logistics, Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

[30] Department of Defense, Office of the Assistant Secretary of Defense, Installations and Logistics, Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

were let to offset the detrimental effect of not having sufficient quantities of a particular military skill in-country and to meet the individual requirements maintenance capability augmentation.[31]

TABLE 66

CONTRACTOR PERSONNEL IN SOUTHEAST ASIA
(FY 68)

Army

Work Category	Vietnam	Thailand
Transportation		
Trucking	2,665	400
Materiel Handling	300	
Stevedoring	7,331	1,250
Ship Crews	40	
Subtotal	10,336	1,650
Laundry Service	1,127	
Packing & Crating Household Goods	83	100
Maintenance	23,384	4,330
Construction	2,436	
Underwater Retrieval		15
Vietcong Mine Study	2	
Total	37,368	6,095

Navy

Work Category	Vietnam	Philippines	Japan	Taiwan	Thailand
Construction & Maintenance of Facilities; Repair & Overhaul of Harbor Craft & Aircraft	8,500	6,000	2,000	500	60

Air Force

Work Category	Vietnam	Thailand
Transportation	129	191
Security	0	4,700
Civil Engineer	784	574
Supply	82	379
School	0	42
Maintenance	286	2,531
Total	1,281	8,417

Source: U.S. Congress, House of Representatives, Committee on Appropriations, Hearings, subject: Military Personnel, 90th Congress, Second Session, 1969, Part 5.

[31] Ibid.

(5) The Navy expanded its commercial ship repair capability because of the increased workloads in the Western Pacific. Table 67 provides an indication of the expansion of depot level Navy ship repair and overhaul from FY 65 through FY 69. To meet immediate public works support requirements, the Navy in FY 68 employed approximately 1,685 Philco Ford personnel in SE Asia, an increase of over 100 percent from the preceding year's contract personnel requirements.

TABLE 67

DOLLAR VALUE OF DEPOT LEVEL CONTRACTING FOR
NAVY SHIP REPAIR AND OVERHAUL
($ Thousands)

Location	FY 65	FY 66	FY 67	FY 68	FY 69
Farm-Out Contracting					
Yokosuka	50	1,773	2,596	1,526	5,180
Sasebo	634	2,671	3,736	3,790	3,426
Subic*		321	242	503	306
Singapore				116**	1,402
Farm-In Contracting					
	FY 65	FY 66	FY 67	FY 68	FY 69
Yokosuka	0	232	364	300	311
Subic	0	0	0	133	449

*Figures represent cost of employment of Filipino National Contract Labor at U.S. Naval Ship Repair Facility, Guam. Commander, Naval Forces Marinanas, Letter to CINCPACFLT Serial 666, 19 March 1969, provided a projected plans for displacement of nonimmigrant alien journeymen to less than 50 at SRF Guam by 1 July 1974.
**Two-month period only in FY 68.

Source: Naval Ship System Command Management Office, Western Pacific Area, Letter, subject: WEST/PAC Farm-In, Farm-Out Statistics FY 69, 15 October 1969.

(6) The Army, because of the rapid buildup of maintenance requirements resulting from the expansion of equipment densities in support of SE Asia, found itself seriously taxed to provide sufficiently experienced, qualified personnel.[32] Army personnel assigned to maintenance units were found to be sufficiently school-trained but lacking experience. They required from 3 to 4 months on the job before becoming proficient. Complex maintenance tasks requiring a high degree of skill were for the most part accomplished with greater efficiency using contractor talent.

(7) The Air Force, which had the least number of contractor personnel involved in the maintenance function in SE Asia, used contractor personnel to release skilled airmen from nonskilled maintenance functions. An example of such a release was the 1.7 million dollar maintenance operation at Kadena Air Base, Okinawa, where two contracts provided 303 personnel to perform intermediate level corrosion control and organizational level washing and cleaning of

[32] Ibid.

aircraft.[33] A sample summary of Air Force maintenance contracts used to support SE Asia operations during the study time frame is provided in Table 68.[34]

TABLE 68

AIR FORCE CONTRACTING IN SOUTHEAST ASIA

Contractor	Maintenance	Contractor Personnel Provided	Cost ($)
Kauwa Saki AcFt Co. Ltd	B57 Iran	40	60,300
Mitsubishi Heavy Industries	F 102 Iran	143	953,692
Philippine Airlines Inc.	C7A Iran	292	1,100,791
Philippine Airlines Inc.	Crash Battle Damage	25	84,505
China Airlines	C123 Iran	44	272,000
China Airlines	C123 Iran	233	761,000
China Airlines	C 47 Iran	166	818,920
China Airlines	Crash Battle Damage	13	44,186
Air America	F100 Iran	364	1,797,000
Air America	F105 Iran	303	1,071,883
Air America	RF 4C Mod	308	1,198,212
Air America	C7A/C123 Maint	118	461,000
Air America	Crash Battle Damage	33	76,300
Lear Siegler, Inc.	C130 Wing Repair	18	83,080
Dynalectron Corp.	Corrosion Control KC 135	48	251,200
Dynalectron Corp.	C130 Wing Flap Rep	28	230,000
Air America	After burner overhaul	40	153,843
Air America	F 100 Wing Insp	32	53,500
Lockheed Aircraft Serv. Co.	C130 Wing Insp	24	350,823

Source: Department of the Air Force, Report of Contractual Services in Support of Operations in South Vietnam and Thailand, 26 March 1968.

(8) Although contract maintenance provided a needed augmentation, it was costly and did not enable the Department of Defense to develop a total war zone organic maintenance capability. Table 69 depicts the total dollar cost of the majority of contracts-in-force in Southeast Asia for all Services as of 19 November 1968. The risks involved in complete dependence on commercial contracts to sustain the war effort are all too obvious to mention. Maintenance personnel experiences associated with Vietnam dictate that the specific role of contractors as an element of the DOD maintenance capability be clearly defined. Contractor use may then be considered as a basic resource for the accomplishment of specified maintenance requirements in CONUS and overseas.

[33] Department of Defense, Office of the Assistant Secretary of Defense for Installations and Logistics, Memorandum, subject: Report of Contract Services in the Pacific Ocean Area, 19 December 1968.

[34] Department of the Air Force, Report of Contractual Services in Support of Operations in South Vietnam and Thailand, 26 March 1968.

TABLE 69

DOLLAR VALUE OF CONTRACTING
BY FUNCTION AND GEOGRAPHICAL DATA

(As of 19 November 1968)

($ Millions)

Function	Japan	Korea	Okinawa	Taiwan	Philippines	Vietnam	Thailand	Singapore	Total
Guard Services and Japan Labor Contract	113.0	7.9	--	--	.3	--	--	--	121.2
Transportation	18.0	5.1	2.8	.1	2.0	53.2	16.4	--	97.6
Stevedoring	3.2	2.2	2.2	--	2.6	51.0	4.2	--	65.4
Subsistence	3.6	4.5	22.0	.7	.8	28.0	1.7	--	61.3
Clothing	--	--	.1	--	--	13.5	--	--	13.6
Maintenance	30.6	4.9	4.2	10.3	5.0	66.4	11.5	4.5	137.4
Communications	39.5	1.2	.8	1.4	.9	7.1	9.7	--	60.6
Repairs & Utilities	1.3	13.8	1.0	.2	.2	128.2	17.6	--	162.3
Miscellaneous	5.7	1.8	.6	--	1.8	9.7	7.0	--	26.6
Total	214.9	41.4	33.7	12.7	13.6	357.1	68.1	4.5	746.0

Note: All contracts in-force in countries visited by the survey team are not listed. Contracts for education, construction, architects and engineers, and utilities and contracts less than $25,000 are excluded.

Source: Department of Defense, Office of the Assistant Secretary of Defense for Installations and Logistics, Memorandum, Report of Contract Services in the Pacific Ocean Area, December 1968.

b. Contract Maintenance in Support of Army Aviation in Vietnam

(1) Maintenance and supply support for Army aircraft in Vietnam became a major task as the densities grew from approximately 600 aircraft in mid-1965 to the present fleet which is in excess of 4,100 aircraft. Table 70 depicts the type and totals of Army aircraft in Vietnam as well as the progressive buildup from 1965 to 1969.

(2) At the commencement of the buildup of aircraft maintenance support in 1965 and 1966, the influx of aircraft into Vietnam preceded the input of maintenance support units. Aircraft maintenance support units (Direct Support and General Support) were being formed in CONUS at this time, but were delayed because of a shortage of equipment and qualified personnel. As a result, the three Direct Support Companies and the one General Support Company in-country were hard-pressed to keep up with the workload as it grew. One area in particular, the airframe repair area, began to hamper the maintenance operation because of the increase in accident and battle damage. Experience in complex airframe repair was scarce as far as military personnel were concerned because this repair had in most cases been accomplished previously in CONUS depots manned by civilians. To offset this lack of capability, it was decided that a contract would be let for repairmen experienced in depot level airframe repair. The Dynalectron Corporation was the first contractor selected to provide aircraft maintenance personnel support. Contract personnel were assigned directly to military units as an augmentation but worked as separate teams under a lead man, with work orders for specific jobs being assigned to each lead man.

(3) As additional aircraft maintenance units arrived in-country, it became obvious that a great many of the personnel were not qualified to perform intermediate and minor depot level repair work without close supervision. The majority of maintenance personnel arriving in-country individually and in units at this time had just completed their maintenance training courses in CONUS and had never worked on any aircraft other than the training aids at the school. As previously mentioned, 3 to 4 months on the job in Vietnam were required before these personnel became individually proficient. The slack time required for on-the-job training (OJT) impacted on the maintenance support capability; and as the rapid buildup of aircraft continued in 1966, it became increasingly necessary to rely on contractor maintenance personnel to augment the capabilities of Army Aviation Maintenance Units. Table 71 depicts the growth of this requirement from FY 65 through FY 70.[35] Table 72 depicts the cost per year and the type of skills purchased.[36]

(4) The necessity for contract maintenance support of Army aircraft in Vietnam can be attributed to several reasons, but the four listed below are probably the most cogent.

(a) Incremental manpower ceilings in Vietnam slowed down the input of military maintenance personnel.

(b) Maintenance requirements escalated faster than trained and experienced military maintenance personnel could be provided once the ceilings were raised.

(c) The lack of an adequate maintenance rotational base meant that the majority of people required training prior to deployment and that experienced personnel returning from Vietnam lost their skill in the absence of a place to work.

(d) Military aircraft maintenance personnel once in-country had to participate in base construction, perimeter defense, and other security efforts, thus limiting their productive time. Contractor personnel could be used full time and did not have to perform the usual housekeeping chores.

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[35] U.S. Army Vietnam, 34th General Support Group (Aircraft Maintenance and Supply), Review and Analysis of U.S. Army Logistics System in RVN, July 1965 to August 1969, 31 August 1969.

[36] Department of the Army, Deputy Chief of Staff Logistics, Memorandum, subject: Contractual Services for Aircraft Maintenance in Vietnam, 27 August 1969.

TABLE 70

TYPES AND DENSITIES
OF ARMY AIRCRAFT IN VIETNAM
(JUNE 1969)

Type Aircraft	Density
Fixed Wing	
O-1	259
U-1	52
U-6	94
U-8	40
U-21	61
OV-1	112
Subtotal	618
Rotary Wing	
OH-6	577
OH-13	--
OH-23	41
OH-58	--
AH-1G	433
UH-1B	132
UH-1C	253
UH-1D	238
UH-1H	1,522
CH-47 (Float)	15
CH-47A	126
CH-47B	81
CH-47C	87
CH-54	31
Subtotal	3,536
Total	4,154

Monthly Density Average

	CY 65	CY 66	CY 67	CY 68	CY 69
Fixed Wing	183	353	444	557	607
Rotary Wing	340	1,380	2,076	2,313	3,547
Total	523	1,733	2,520	2,870	4,154

Source: Department of the Air Force, Report of Contractual Services in Support of Operations in South Vietnam and Thailand, 26 March 1968.

TABLE 71

CONTRACT MAINTENANCE MANNING LEVEL,
ARMY AVIATION, REPUBLIC OF SOUTH VIETNAM

Company	FY 65	FY 66	FY 67	FY 68	FY 69	FY 70
Lockheed Aircraft	--	--	--	100	232	287
Lear Siegler, Inc.	--	--	457	624	832	733
Dynalectron Corp.	34	239	550	847	1056	872
Total	34	239	1007	1571	2120	1892

Source: Department of the Air Force, Report of Contractual Services in Support of Operations in South Vietnam and Thailand, 26 March 1968.

TABLE 72

COST, MAN-HOURS, AND SKILLS

Cost

Contractor	FY 66	FY 67	FY 68	FY 69	FY 70*
Dynalectron	$3,074	$1,632,624	$10,924,000	$14,919,817	$18,278,760
Lear Siegler	--	1,199,920	8,841,333	15,103,927	15,365,146
Lockheed	--	--	634,671	2,869,864	6,016,094
Total	$3,074	$2,832,544	$20,400,004	$32,893,608	$39,660,000

Man-Hours

FY	Man-Hours Purchased
66	506
67	427,200
68	3,388,755
69	5,464,264
70	5,903,040*

Skills

Classification	Percent**
Senior (Systems Specialist) Mechanic	32
Electronic Technician	27
Airplane General Mechanic	20
Lead Men	10
Inspector	4
Mechanic I	4
Mechanic II	2
Engineer	1

*Estimated.
**Percent of total civilian work force engaged in each skill during FY 67-69.

Source: Department of the Air Force, Report of Contractual Services in Support of Operations in South Vietnam and Thailand, 26 March 1968.

(5) Commercial contract maintenance played an important and necessary role in keeping Army aircraft weapons system operational in Vietnam. Performance standards and quality of work with few exceptions have been above reproach. Security, messing, transportation, and housing of contract personnel presented problems of no more significance than would have resulted from a like number of military personnel. Use of contract personnel added flexibility in a constantly shifting maintenance environment. Under three contracts with a total of 1,892 personnel authorized for FY 70, 1,448 or 76.5 percent are engaged in maintenance support with the others assisting in the supply fields.

(6) Of the total of 1,892 personnel authorized for FY 70, the 34th General Support Group has 1,333 assigned in-house, with an additional 125 working with operating units and maintenance detachments to augment their sheet metal capability. The remaining 434 personnel provided augmentation to all divisional aircraft direct support units plus separate medical aviation companies. It has been estimated that to replace the contract civilians engaged in Army aircraft maintenance based on the man-hours procured and the productive man-hours of a Direct Support Company, it would take 16 additional Direct Support Aircraft Maintenance companies.[37]

9. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) The shortage of qualified experienced maintenance personnel, although affecting each of the Services worldwide maintenance capability, had a greater impact on the Army than on the other Services. The Army required increased quantities of maintenance personnel to establish and replenish its logistic support base in Vietnam (paragraphs 1b(3) and 2a(2)).

(2) A transition period is needed on type equipment after formal schooling before an individual can be considered maintenance qualified. The Army, because of the short tenure of its 2-year draftee, was usually prohibited from providing practical experience on equipment during the interim period between formal schooling and assignment to the combat zone (paragraphs 1b(3), 7a, and 7b).

(3) Retention rates are unsatisfactory in most critical skills (paragraph 2b).

(4) An adequate maintenance rotational base at the intermediate level exists in all Services except the Army (paragraphs 1b(3), 2c, and 2d(5)).

(5) The military and civilian mix at the depot level of maintenance in all Services is predominantly civilian (paragraphs 2c and 2d(6)).

(6) Contract maintenance provided an invaluable service by ensuring continuity in a shifting military personnel situation, accomplishing depot level repair tasks for which military personnel were not available, and releasing military personnel for more direct combat support maintenance assignment (paragraph 2d(7)).

b. Recommendation. See Chapter III, Army Maintenance, Recommendation MT-2.

[37] Department of the Army, Deputy Chief of Staff Logistics, Memorandum, subject: Contractual Services for Aircraft Maintenance in Vietnam, 27 August 1969.

CHAPTER XI
AUTOMATIC DATA PROCESSING SYSTEMS

1. INTRODUCTION

a. The impact of advanced technology has been felt in the area of automatic data processing systems (ADPS) in support of maintenance management. Throughout the military services, government, and industry, there has been increasingly widespread use of this important tool. Because of this, and due to strong comments in favor of increased ADP which were made to members of the Joint Logistics Review Board during its visit to Southeast Asia, this chapter was developed.

b. All the Services use ADPS extensively. The way in which they do so within guidance furnished by the Office of the Secretary of Defense is explored in subsequent portions of this chapter.

c. The evolving approach is toward a more effective and efficient use of ADPS through standard systems applied within uniform rules. This approach is shaped by an awareness of the massive potential which ADPS affords for improved management and use of resources, as well as by the hard fact that such systems are costly to develop and operate, and proliferation of unique systems can be wasteful.

d. The scope of this chapter is limited to the use of digital automatic data processing systems for maintenance management purposes. It does not include command and control systems, intelligence systems, engineering communications systems, analog applications, research and development projects, or those computer systems which are an integral part of a weapons system.

e. All references to ADPS include the entire spectrum of ADP systems consisting of computer software, programs, hardware, etc.

2. DESCRIPTION

a. Department of Defense

(1) The Office of the Secretary of Defense (OSD) applies modern computer techniques within management systems and encourages their use throughout the Department of Defense. This is accomplished through assignment of responsibilities for administration of ADP, and by prescribing standardization in vital areas such as data elements and codes.

(2) OSD policy and guidance are reflected in maintenance by instructions and directives which are progressively becoming more specific and comprehensive. This stems from basic guidance for each military department to ensure capability to a designated degree of military maintenance.

(3) Further guidance for depot level maintenance encourages sound and up-to-date management using new methods, procedures, and devices. Instructions which formerly have emphasized uniform depot maintenance cost accounting and production are now expressed in detailed guidance for support programming which may require extensive revision to Service systems.

(4) Other recent OSD guidance applicable to all levels of maintenance requires comprehensive performance measures. Detailed procedures and reporting instructions have been published.

(5) Still another directive in the final development stages provides for the establishment of a uniform equipment maintenance management information system applicable to all levels of maintenance, and may force restructuring of some Service systems or subsystems.

(6) An equipment, distribution, and condition (EDAC) reporting system is also in effect, which culminates in a quarterly report to OSD from each Service giving prescribed information about designated equipment.

(7) Documents containing information outlined above are:

Department of Defense Directive 4151.1, Policies Governing the Use of Commercial and Military Resources for Maintenance of Military Materiel, 28 June 1960.

Department of Defense Directive 4151.2, Management of Depot Maintenance Activities, 3 October 1960.

Department of Defense Directive 5000.11, Data Elements and Data Codes Standardization Program, 7 December 1964.

Department of Defense Directive 5010.24, Logistics Performance Measurement and Evaluation System, 29 May 1969.

Department of Defense Directive 5100.40, Responsibilities for the Administration of ADP Equipment Program, 24 January 1969.

Department of Defense Directive, Department of Defense Equipment Maintenance Management Information System, under development.

Department of Defense Instruction 4151.15, Depot Maintenance Support Programming Policies, 24 May 1969.

Department of Defense Instruction 5000.12, Data Elements and Data Codes Standardization Procedures, 7 December 1964.

Department of Defense Instruction 5010.25, Logistics Performance Measurement and Evaluation System—Procedures and Reporting Instructions, 19 June 1969.

Department of Defense Instruction 7220.29, Uniform Depot Maintenance Cost Accounting and Production Reporting System, 28 October 1968.

Department of Defense Instruction 7730.25, Equipment Distribution and Condition (EDAC)—Measuring and Reporting System, 13 February 1968.

(8) There is a trend toward a more detailed interest by OSD in Service maintenance operations. Such interest when confined to policy guidance and criteria for standard system development is good. However, when such interest takes the form of increasing reporting requirements and more detailed statistical data, an uneconomical chain reaction results, as each successive lower level of management, under the guise of self-protection, sets forth its demand for more management data.

b. Joint Chiefs of Staff (JCS). The JCS does not administer ADP systems for maintenance management or systems which use maintenance information exclusively. However, maintenance related items are involved in some systems. The JCS staff follows the procedures contained in Defense Communications Agency Instructions for ADPS internal staff systems development.[1] If

[1] Defense Communications Agency Instruction 210-175-3, Documentation Standards, 14 May 1968.

the ADPS have application to the unified and specified commands or the Services, the systems are included in JCS PUB 6.[2]

c. Army

(1) The basic maintenance management system is the Army Integrated Equipment Record Maintenance Management System (TAERS).

(2) TAERS procedures are defined in technical manuals and are applicable to all Army owned equipment in units, organizations, and activities under the jurisdiction of the Department of the Army.[3]

(3) TAERS is designed to:

(a) Establish a single Army system that will provide the necessary equipment record and report forms and logistic data summaries for management of the maintenance and supply effort at all levels of command.

(b) Establish a means for generating essential data for engineering evaluation and consideration in the design of new equipment, redesign of current equipment, and product improvement.

(c) Provide essential information for the evaluation of the readiness condition of selected items of Army materiel to include status, inventory, effectiveness of maintenance operations, adequacy of resources, and an indication of maintenance support including manpower and repair requirements.

(d) Establish a maintenance data bank as a source of reference for evaluating maintenance problem areas, providing information for maintenance and supply studies and detailed analyses, and verifying the adequacy of maintenance support requirements in the development of new organization.

(4) The types of reports to be found in the TAERS system are:[4]

(a) Materiel deficiencies

(b) Maintenance replacement rates

(c) Modification accomplishments

(d) Equipment history files

(e) Maintenance and supply correlation

(f) Indicators of equipment availability, reliability, and maintainability

(g) Equipment configuration.

(5) Some typical uses of TAERS data are:[5]

(a) To improve records at unit level

[2] Joint Chiefs of Staff Publication 6, Joint Operations Reporting System, April 1969.
[3] U.S. Army Technical Manual 38-750, Army Equipment Record Procedures, May 1967; U.S. Army Technical Manual 38-750-1, Field Command Procedures, May 1964; and U.S. Army Technical Manual 38-750-2, National Agency Procedures, June 1964.
[4] Department of the Army (DCSLOG), Briefing to the Joint Logistics Review Board, subject: The Army Integrated Equipment Record Maintenance Management System (TAERS), 29 May 1969.
[5] Ibid.

(b) To conduct combat vehicle studies

(c) To report materiel readiness

(d) To improve control.

(6) Other uses for TAERS data have been developed. Table 73 shows a representative grouping.

TABLE 73

THE ARMY EQUIPMENT RECORD SYSTEM (TAERS)
INFORMATION ELEMENTS

Information Element	Use	Reference
Usage Rate	Depot overhaul Component overhaul End item replacement	AR 750-4, AR 711-45, AR 750-5, Equipment TM
Location	Maintenance factors Environmental conditions	AR 750-2, AR 705-50
Fuel Consumption Rate	Maintenance factors	AR 750-2
Frequency of Adjustments	Reduce number inspection points thereby reducing maintenance time	AR 750-2
Scheduled Maintenance Time	Maintenance factors	AR 750-2
Frequency of Repair	Achieved availability Reduce inspection points Maintenance factors Cost of maintenance	AR 705-50, AR 750-2, AR 750-6, AR 750-1, AR 750-5, AR 37-108
Mean-Time-to-Repair (MTTR)	Achieved maintainability Maintenance factors Cost of maintenance	AR 705-50, AR 750-6, AR 750-1, AR 750-5, AR 750-27, AR 37-108
Replacement Rate (End Items, Components, and Time Change Components)	Supply control Component overhaul Depot overhaul Repair parts and component allowances	AR 711-16, AR 711-45, AR 700-87, AR 750-5, AR 710-50, AR 711-25, AR 700-18, AR 710-45
Mean-Time-Between-Failure (MTBF)	Achieved reliability Maintenance factors Cost of maintenance	AR 705-50, AR 750-1, AR 750-5, AR 750-6
Parts Usage Rate	Supply control Repair parts allowances	AR 700-18, AR 705-50, AR 750-2, AR 37-108
Cause of Failure	Maintenance factors	AR 750-2
First Indication of Trouble	Maintenance factors	AR 750-2
Turnaround Time	Maintenance factors Depot overhaul	AR 700-69, AR 750-4, AR 750-5, AR 750-27

(7) Annual punch card volume generated through TAERS has totaled 37,288,000 cards, or a monthly average of over 3,000,000 cards. In 1965 the Army was reporting on 900,000 items of equipment. By 1967 this quantity had grown to 1,100,000 items.[6]

(8) The reporting volume has caused problems in data processing support and led to a reevaluation of the scope of TAERS reporting. As a result, there will be a reduction of 70 percent in punch card volume. This cutback is expected to reduce the reporting load on operating units and ADP support activities while improving information accuracy and timeliness.

(9) Other improvements to TAERS include:[7]

(a) More useful reports at the operating level

(b) Increased command level reports

(c) More selective development of data bases.

(10) The changing scope of TAERS, usefulness from a primary emphasis on record keeping to the broader role of maintenance management information system is recognized by a title redesignation from TAERS to TAMMS (The Army Maintenance Management System).

(11) Other system developments now underway which affect maintenance are:

(a) The Combat Service Support System (CS3) uses transportable third-generation computer equipment to provide on-line communications and support for the Army in the field.[8]

1. CS3 is designed to increase support responsiveness by providing special reports more rapidly through remote stations tied to the central processor.

2. Maintenance is one of several functional areas supported. The Maintenance Reporting and Management (MRM) subsystem of CS3 is designed to maintain a data base of automated files concerning the current operational status and maintenance activity of equipment in the hands of using units. Scheduled reports and responses to interrogation will be furnished.[9]

(b) The Continental Army Command Class I Automated System (COCOAS) was originally envisioned to provide standard ADP programs and hardware at installation level in the continental United States.[10] The scope may now be expanded worldwide. Primary COCOAS objectives are improved readiness through more accurate and timely data, standardization, integration of systems, and increased application of management by exception. Initial efforts focus on military personnel, supply, and financial management. Maintenance management will be included in follow-on development, which will include TAERS, shop stock, production planning and control, and related pertinent items.[11]

(12) The mechanization of direct and general support units by addition of National Cash Register 500 equipment automates manual stock accounting procedures to improve supply response to maintenance at that level. Approximately 50 units are now in Southeast Asia, and extension of the system is continuing.

(13) Continental United States (CONUS) depot maintenance is included in the System-wide Project for Electronic Equipment at Depots (SPEED) program which provides a standardized,

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[6] Ibid.
[7] Ibid.
[8] U.S. Army Computer Systems Command, Command Fact Sheet, undated.
[9] U.S. Army Computer Systems Command, CS3 Fact Sheet, undated.
[10] U.S. Army Computer Systems Command, COCOAS Fact Sheet, undated.
[11] Ibid.

integrated, and automated system in support of the full range of data processing requirements for a multipurpose depot.[12]

(14) The SPEED system is being improved through the Speed Extended (SPEEDEX) program which permits the introduction of new management concepts as well as enlargement of concepts introduced under the SPEED program. SPEEDEX will include greater real-time processing and use of remote input-output stations, as well as expanded production planning and control.[13]

(15) SPEEDEX is part of the National ADP Program for AMC Logistics Management (NAPALM). NAPALM encompasses maintenance management at the Commodity Command, National Maintenance Point, and also maintenance management within the depots.

(16) NAPALM encompasses the entire logistics area. However, its impact on maintenance is large, as the depot overhaul activity alone has increased from $300 million in FY 1965 to $658 million in FY 1969.[14]

(17) NAPALM not only processes a greater volume of information and does this more rapidly, but it also correlates and integrates key information files which can be accessed in a single cycle to process data for a variety of functional managers.[15] Thus, maintenance and other managers have access to more comprehensive and useful information not confined to one specific functional area or resource.

(18) The NAPALM system is under development with implementation dates ranging from July 1970 to July 1974. The maintenance portion of this system is currently scheduled for development during the 1971 time frame with implementation envisioned in 1972.

d. Navy

(1) The Maintenance and Materiel Management (3M) system is used for the planned maintenance system for ships, and reporting maintenance actions and related activities for both ships and aircraft.[16]

(2) The system is designed for effective use at the lowest level, but with information feeding upward into other echelons and systems. Daily and monthly summaries and other methods are used. In this manner, the Chief of Naval Operations (CNO) is aware of individual activities performance, but control is exercised by the immediate superiors of the individual.

(3) Navy-wide data are gathered at a central data repository, the Maintenance Support Office (MSO), Mechanicsburg, Pennsylvania. Fleet data are used by Headquarters personnel for reliability and maintainability analysis and are provided to contractors to assist them in the design of future weapons systems, as well as to monitor the performance of existing equipment.

(4) The 3M system consists of two separate systems for ships and aviation.

(a) The aviation system has three subsystems:

1. Maintenance Data Report (MDR) of each maintenance action—the when, what, and how.

[12] Department of the Army, Briefing to the Joint Logistics Review Board, Army Logistics Systems, 2 May 1969.

[13] U.S. Army Materiel Command, subject: Five Year ADP Program FYs 1971-1975, 30 September 1969.

[14] U.S. Army, Presentation to the DOD Conference for Review of Major Automated Logistics Systems, Fort Ritchie, Md., Review of Army Major Automated Logistics Systems, 13-14 September 1969.

[15] Ibid.

[16] U.S. Navy Manual, Naval Aviation Maintenance and Materiel Management, 15 November 1964; U.S. Navy Manual, Maintenance and Materiel Management (3M) OPNAV 43PZ, March 1965.

2. Man-hour Accounting (MHA) including exception accounting of all time other than that recorded on the MDR.

3. Equipment Distribution and Conditions (EDAC) reports providing aircraft and support equipment readiness in terms of Not Operationally Ready Maintenance (NORM), Not Operationally Ready Supply (NORS), and other measures.

(b) The ships system has two subsystems:

1. The planned maintenance subsystem

2. The maintenance data collection subsystem.

(5) The 3M system is a card-oriented system, as information flows through the system on punch cards via mail or Automatic Digital Network (AUTODIN). Card flow to Maintenance Support Office (MSO), was 50,000 the first month of system operation in 1965. Card quantity at the end of 1969 reached approximately 5.2 million cards per month. The data banks have stored the information contained in 117 million cards. This information is contained in a 618 tape master input file. Approximately 10,100 other tapes are also used as working files.

(6) There are 187 unique products produced by MSO on a regular basis for approximately 2,000 customers. Although most are monthly reports, some are produced every 10 days, quarterly, or semiannually. The average number of recurring products is 130 per month. About 40 one-time product requests are procured each month.[17]

(7) The data base is split into functional areas to facilitate data retrieval. For example, the aviation data base is divided as follows:[18]

(a) Aircraft statistical data

(b) Materiel data

(c) Maintenance data

(d) Reparable data

(e) Technical directive compliance data

(f) Man-hour accounting data

(g) Support action data

(h) Removed/installed data

(i) Maintenance support equipment statistical data

(j) Naval air rework facility (NARF) data.

(8) Standard recurring products fall into areas such as:[19]

(a) Readiness/utilization

(b) Personnel utilization

[17] U.S. Navy, Maintenance Support Office, Briefing to the Assistant Secretary of Defense (Installations and Logistics), Its Role in the Navy, 23 April 1969.
[18] Ibid.
[19] Ibid.

(c) Reliability/maintainability

(d) Support and services

(e) Special evaluation.

(9) Emphasis is placed on historical information. For example, some of the ships system on-board records are:[20]

(a) Hull history

(b) Machinery history

(c) Electrical and electronic history

(d) Repair record.

(10) Some examples of specific maintenance areas in which data have proved especially useful are:[21]

(a) Workload management control

(b) Requirements forecasting

(c) Detecting trends

(d) Isolating trouble spots

(e) Performing detailed analyses.

(11) The current Navy 3M system is performing satisfactorily. However, the following potential areas that could be improved are being examined:

(a) The policy for source data collection is for personnel at the operating level to document only once concerning a maintenance event. Continuous emphasis will continue to be placed on this important aspect of the system.

(b) Source data collection procedures may be improved from the conventional keypunching and conversion procedures to more advanced methods. Some advancements under consideration are typewriter-card-tape devices and cathode ray tube displays associated with remote input-output terminals.

(c) Accelerated reporting can be implemented for more intensive review of key areas, such as weapons system readiness trends. This procedure can be used when and as necessary to focus on desired areas.

(d) The large reporting workload is an area receiving attention. Desired goals are a more selective data collection with a consequent reduction in volume and related improvement in timeliness and accuracy. Consideration will be given to averages and means for failure, man-hours, elapsed time, etc. Trend charts and graphs may also come into increased use.

(e) The Navy recognizes the need for increased interface between maintenance systems and other logistics information systems. Hence, the Navy has recently established two coordinating and monitoring systems. One is the Navy Integrated Command/Management Information System (NAICOM/MIS) sponsored by the Chief of Naval Operations (OP-91), and the other

[20] Ibid.
[21] Ibid.

is the Navy Logistic Information System (NAVLIS) sponsored by the Chief of Naval Material (PM-14). In this hierarchy of information systems, 3M is a part of NAVLIS, which is in turn a part of NAICOM/MIS.

(f) Computer equipment is being updated to provide faster processing time and more cost-effective reaction to system needs. Related changes to software are also being made.

(g) The 3M maintenance data collection system for ships is undergoing a major modification. Forms, data elements, and computer programs are all being revised.

(12) The depot maintenance system is also receiving particular attention. At present, 3M fully embodies the organizational and intermediate levels of maintenance and collects some gross statistics for the depot maintenance level. However, several systems perform depot maintenance functions. These systems include:

(a) Management Information System (MIS)—Snipyards

(b) Naval Ordnance Management Information System (NOMIS)—Ordnance Activities

(c) Industrial Naval Air Stations (INAS).

(13) The job is a large one. The sheer volume of information is reason enough for improvement. At a 10,000-man shipyard, 5,000 mechanics normally work on five to 40 ships in a given day, using 4,000 items of shop stores materiel, monitoring progress on from 1,000 to 15,000 major tasks performed on each ship, and accounting for 18,000 labor expenditures per day.[22]

(14) All major depot maintenance systems include provision for planning maintenance, scheduling resources for maintenance, controlling and reporting maintenance performance, returning repaired items to the system, and feedback to information to managers. All of the above systems are undergoing refinement to improve techniques and utilize the increased potential of advanced computers. Some examples of this refinement are:

(a) The MIS (Shipyards) current organization into Industrial Management Financial, and Materiel subsystems is being modified to provide further integration where pertinent. Further, source data automation will expand use of pre-punched cards to relieve supervisory personnel of many clerical functions. Repetitive and variable data will be collected on paper tape for preparation of management reports.[23]

(b) NOMIS (Ordnance) is receiving major modification which groups and selectively integrates eight subsystems to provide improved management and control. Planned maintenance and collection of maintenance data will be greatly expanded. More powerful computer equipment is an important factor in the modified system.

(c) Information systems in support of aviation depot maintenance are being improved through the Uniform Automatic Data Systems for Industrial Naval Air Stations (UADPS for INAS). One system being improved is the Navy Integrated Comprehensive Repairable Item Scheduling Program (NICRISP) which is the system by which repairable assemblies are managed by predetermining requirements and shop production schedules. Scheduling is performed weekly using a NICRISP priority ranking technique which is used for shop loading. Management reports are provided for workload control, programs, and performance.

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[22] Department of the Navy, Navy Management Review, Article, title: U.S. Naval Ship Systems Command Management Information System for Naval Shipyards, July 1968, pp. 7-10.

[23] Department of the Navy, Navy Management Review, Article, title: Source Data Automation in Naval Shipyards, July 1968, pp. 15-17.

(15) The Navy has recognized the need for more effective systems in individual functional areas and also the requirement to tie these systems together into an overall structure. Progress is being made in both areas.

e. Marine Corps

(1) Marine Corps forces obtain maintenance support through two maintenance systems, the Marine Corps Maintenance System and the Navy Maintenance System. Specifically, Marine Corps Aviation follows Navy procedures for aviation, whereas other Marine Corps elements receive support through systems described in the following paragraphs.

(2) Equipment Distribution and Condition (EDAC) is reported through the Marine Corps Automated Readiness Evaluation System (MARES) (Marine Corps Order 3000.2B). MARES is primarily a unit readiness reporting system. The logistic portion of MARES deals with the status of combat-essential equipment, the reason for deadline, and expedition of supply action on critical requisitions. These data are used by maintenance managers to monitor the deficiencies, deadlines, and maintenance posture of reportable combat-essential equipment. The information is reported via AUTODIN to Headquarters, USMC, by the requisitioning, owning, or repairing unit.

(3) The Marine Corps is currently developing the Marine Corps Integrated Maintenance Management System (MIMMS). In the interim, a number of individual systems are used to accomplish the maintenance function. The following are representative:

(a) Automated Reporting Materiel Management System (ARMMS) (Division Order P 4700.6, 2nd Marine Division). This system uses deadline information on Division assets as the basic source data. By tracking the maintenance status of individual assets, both detailed and summary reports may be generated which serve a number of maintenance and readiness oriented managers within the Division.

(b) Mechanized Maintenance Control System (MOCSY) (MOCSY Handbook, 2nd Force Service Regiment). MOCSY uses the equipment repair order and supply requisition data as daily input. From this, it outputs equipment status reports to the Commandant of the Marine Corps (CMC) (MARES) and the owning unit, maintenance recapitulations to the repair shops, and supply demand history to shop stores personnel. In the future, more budgeting and cost information will be generated.

(c) Automated Reporting Maintenance System (ARMS) (Maintenance Battalion Order P4230.1, 3rd Force Service Regiment). Using "on occurrence" card input from the maintenance shops as the basic working data, this system builds four primary files: the equipment repair order file, the material (requirements) file, the manpower utilization file, and the maintenance balance/rebuild file. Reports generated from this data base are distributed to maintenance managers at shop and staff levels where they are used to monitor and manage the maintenance operations.

(d) Data Automated Maintenance System (DAMS) (Regiment Order 5230.5, 5th Force Service Regiment). Four basic pieces of information are input to the system: equipment repair order data, required repair parts data, requisition status, and job closeout data. The balance of this information enters the system on optical scanner code sheets from the maintenance shops. Reports on maintenance status and quantity of equipment repair orders, as well as job cost and equipment defect information, are output for managers at shop, staff, and command levels.

(4) MIMMS will improve and standardize the management of Marine Corps maintenance. MIMMS is designed to give the maintenance manager those management tools required to adequately analyze and predict his available resources and future resources requirements. It will encompass a maintenance management system for all equipments of posts and stations (less fixed facilities), repair depots, and aviation ground support equipment not covered by the Navy 3-M system.

(5) MIMMS will interface laterally with Marine Corps Unified Materiel Management System (MUMMS) and Supported Activity Supply System (SASSY). In addition, it will interface with other systems comprising the Integrated Information System (I^2S) package, which is in turn an interface between all Marine Corps functional systems and between these systems and the appropriate Navy and DOD systems. This will provide the functional managers with the most current information to ensure proper planning, programming, coordination, and assessment with respect to their information requirements.

(6) The installation of a maintenance system with terminals at the lowest practicable levels will provide a means for real-time response to maintenance problems. Developing trends in equipment failures, parts replacement, or maintenance personnel requirements will be detected early so that appropriate remedial action can be promptly initiated.

(7) This system will permit responsive management of maintenance resources. For example, economy of resources, including appropriate inventories of repair parts, accessories, tools, and test equipment can be realized. The system will allow these resources to be positioned where and when required to support the using unit, without multiplicity and excessive stocks.

(8) Additional features will permit the development of Marine Corps-wide standards for procedures assurance/quality control and resource expenditures for all items under control of the maintenance manager. Also, sound financial management will be employed to ensure that maintenance actions accomplished at all levels produce the optimum return for each dollar invested in maintenance.

(9) The general goal is to develop a maintenance system that is responsive to the needs of the commander and results in maximum materiel readiness. This goal will be attained by a fully automated, centrally managed, modern and dynamic maintenance system for the Marine Corps.

(10) The depot maintenance system of the Marine Corps is supported by the Depot Maintenance Management System (DMMS) (Marine Corps Order P4400.81). DMMS is a subsystem of the Marine Corps Unified Materiel Management System (MUMMS). It is the automated portion for maintenance management of the Depot Maintenance Activities at the two Marine Corps Supply Centers. The system deals with manpower management, materiel requirements, job scheduling, costing, and budget data. The system does not prescribe total local operating procedures, but rather establishes those procedures that are essential to ensure that management at the depot level will meet the operating and productivity standards for this element of the overall Marine Corps equipment maintenance program.

(a) Within its design this system has incorporated management and production control exception reports which trigger immediate management action to bring specific planned workloads within predetermined or established parameters.

(b) In the area of performance standards, this system with its feedback reporting subsystem provides the means for analyzing the cause and effect of inadequate coverage and a deficient performance against standards, reporting by type of product or service and operation.

(11) Although the DMMS is designed for use in the repair divisions of the Albany and Barstow Centers, attention has been given to future application in other activities, including the Fleet Marine Force, at such time as it is needed.[24]

(12) At the Headquarters, Marine Corps/Inventory Control Point (ICP) level, constant analysis of the Commandant of the Marine Corps (CMC) Repair Program progress is maintained

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[24] Headquarters, United States Marine Corps, Presentation of the JLRB, Marine Corps Unified Materiel Management System (MUMMS), 22 August 1969.

through the use of weekly production progress reports, monthly mechanized management reports, and quarterly review and analysis reports submitted by the Depot Maintenance Activities.

f. Air Force

(1) Air Force Manual 66-1[25] prescribes a standard maintenance management system. It is primarily applicable to organizational and intermediate levels of maintenance. A uniform organizational structure and basic operating procedures are included. These are designed for effective and efficient use of resources within a standard framework throughout the Air Force.

(2) A maintenance management information system is an integral part of the standard maintenance management system. Its primary purpose is to provide managers of organizational intermediate levels of maintenance with information needed to enhance their surveillance and control of maintenance activities. Information is originated within the maintenance organization as events occur. It is processed into standard reports which are used by the Chief of Maintenance and his staff to review accomplishments, monitor ongoing activities, identify potential trouble areas, and perform scheduling functions.

(3) A two-pronged Maintenance Data Collection (MDC) system has been designed to accomplish the above-mentioned purpose. The system permits collection of pertinent information related to maintenance equipment, while also providing man-hour information about the work force utilized.

(4) The maintenance data documentation portion of the system is designed to record production credit for all tasks accomplished by maintenance personnel requiring expenditure of direct labor. Coding is used for processing this information through punch card accounting machines and computers to produce summary reports and detailed analysis products focusing on key aspects of the maintenance operation.

(a) Reports include production summaries which show local managers how the available man-hours were utilized, what man-hour transfers were necessary within the maintenance organization to balance the workload, and what man-hours related to equipment types were expended. Direct labor used to fulfill specific work orders is also shown. System and component discrepancy reports are provided for analysis to determine problem areas in particular weapon systems or equipment items. Malfunction summaries, quantities of failures of a given type, and other such information provide the basis for trouble isolation and more effective maintenance management.

(b) Information is also forwarded to higher level maintenance managers and to the Air Force Logistics Command, where the volume of punched cards processed is approximately 5,500,000 maintenance actions each month.[26] At AFLC this information becomes input to broader materiel systems which provide the following:[27]

1. Early identification of flight safety deficiencies

2. Determination of item reliability

3. Identification of items requiring product improvement

4. Identification of maintenance malpractices

5. Identification of deficient Technical Instructions

[25] Air Force Manual 66-1, Maintenance Management, 11 March 1968, as amended.
[26] U.S. Air Force, Air University, AFIT, School of Systems and Logistics, Handout for Course 210 (DOD), "Why Do We Do It?" AFLC-WPAFB, February 1969.
[27] Air Force Logistics Command Publication, Maintenance Engineering 1968, AFLC-WPAFB, October 1968.

6. Identification of items consuming excessive man-hours

7. Identification of items adversely affecting operations

8. Monitoring of Time Compliance Technical Order (TCTO) accomplishment

9. TCTO workload planning

10. Verification of modification effectiveness

11. Use of configuration data for Configuration Control Board (CCB) actions

12. Failure predictions by actuarial techniques

13. Improved maintenance program

14. Time change item forecasting.

15. Factor-input-to-requirements computations (percent condemned, percent not repaired at base, and percent base reparable generations)

16. Bit and Piece usage data

17. Percent of base maintenance capability

18. Compatibility of Airborne Vehicles with Aerospace Ground Equipment (AGE)

19. Early identification of potential critical items

20. Materiel Improvement Project (MIP) status

21. Determination of excessive Not Operational Ready Maintenance (NORM) rates

22. Identification of items causing high aircraft unscheduled maintenance downtime or NORM

23. Increased Reliability of Operational Systems (IROS).

(c) A pictorial representation of data flow and some basic AFLC uses for this information is shown in Figure 42.[28]

(5) The man-hour reporting portion of the system provides a uniform man-hour accounting system for all maintenance organizations. It is designed to separate man-hour expenditures into broad categories of usage to indicate the investment of man-hours which are not reported in direct support of maintenance under the maintenance data collection portion of the system.

(6) By properly matching the results of the two-pronged system, a maintenance manager at any level can totally relate available work force to work accomplished and obtain an indication of its effectiveness and efficiency.

[28]U.S. Air Force, Air University, AFIT, School of Systems and Logistics, Study Brochure, Maintenance in the Air Force, AFLC-WPAFB, May 1962, p. 38.

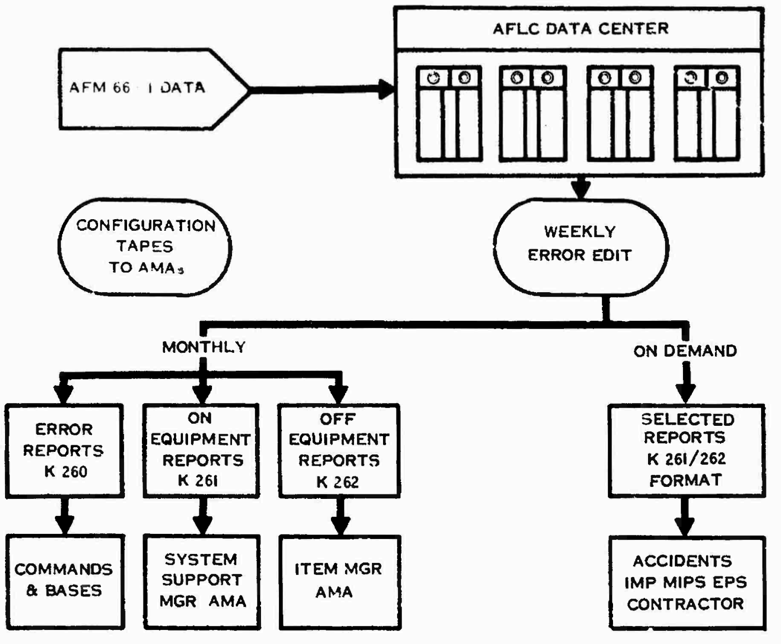

FIGURE 42. REPRESENTATIVE DATA FLOW

(7) Information from this system is also input to the manpower reporting system of the Air Force, where it is considered along with other factors in manpower computations.

(8) The Air Force also maintains an Equipment Distribution and Condition (EDAC) reporting system.[29] The system is used at an organizational intermediate level as a part of the continuous hour-by-hour management of maintenance and shows which equipment is in commission and out of commission along with reasons for such conditions. Aircraft which are in depot for IRAN (Inspection and Repair as Necessary) are also reported under this system. Reports are forwarded to higher management echelons, eventually culminating in a quarterly report to the Department of Defense level.

(9) Though these systems have improved maintenance management, basic problems are apparent as the systems receive extended use on a large scale. One problem is the difficulty in obtaining error-free input data to the system. Another is the cumbersome nature of machine listings which are returned to maintenance managers for their use. A third major problem, the most troublesome, is the difficulty in providing management products to maintenance managers in a timely manner.

(10) Each problem is receiving attention in the Maintenance Management Information and Control System (MMICS) development.[30] MMICS is the computer assisted system for use

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[29] U.S. Air Force Manual 65-110, Standard Aerospace Vehicle and Equipment Status Reports, 1 August 1968, as amended.

[30] U.S. Air Force Data Systems Design Center, MMICS System Description, 1 August 1969.

by organizational intermediate maintenance managers in the early 1970's. It exploits third-generation computer capability to assist managers by performing numerous tedious and repetitive tasks which now consume large portions of a manager, time. It will unburden managers from many such requirements and permit focusing a greater share of management attention upon more significant areas.

(11) MMICS addresses the three major problems in the following way:

(a) The input data error rate will be reduced by:

1. Requiring less information from the originator, as the computer will already "know" routine information about the job being accomplished.

2. Making it easier for the originator to input information. This will be done by a remote device in the maintenance area which is tied directly to the computer system.

3. Subjecting the input information to an immediate and extensive error check by the third-generation computer system, and telling the originator in plain language while he is still there that he made an error and should correct it promptly.

(b) The cumbersome nature of machine listings will be improved by:

1. Redesigned formats which provide the maintenance manager with the information pertinent only to his individual operations, and not with a complete summary or a complete calendar series of information.

2. Providing only information requested. Managers will not receive periodic voluminous listings, but will instead know available formats and request them when desired.

(c) Providing information in a timely manner will be accomplished by:

1. Information output by a remote device in the maintenance area instead of by a voluminous listing in the base data processing facility with subsequent delay for segregation, distribution, etc.

2. Information given the maintenance manager within minutes of his request for information.

3. Information which is immediately and continuously current, as it comes from the base-level computer data base which is updated continuously as information is input from any valid source.

(12) Many other improvements are included in the MMICS. Some are the result of improved management techniques and some are the result of progress in computer technology which makes devices feasible now which could not work adequately in a manual or semi-automated environment.

(13) Depot maintenance is a large and important area of operation which consumes many resources. In the production or repair area, the depot maintenance workload is about 114,000 man-years. To accomplish this workload, there are some 52,000 civilian employees in the Air Materiel Areas. Forty-six percent of the workload is accomplished organically and the remaining 54 percent is accomplished on contract.[31] The cost of Air Force Logistics Command

[31] Air Force Logistics Command Publication, Maintenance Engineering 1968, AFLC-WPAFB, October 1968, p. 51.

maintenance facilities and equipment for FY 69 was $654.8 million.[32] Costs of this magnitude highlight the need for good management.

(14) Effective depot maintenance systems have existed for a number of years, and these are currently in transition to take advantage of improved techniques and more modern equipment. This type of improvement is a part of the Advanced Logistics System (ALS) development, which involves redesign of existing systems and use of large-scale third-generation on-line computer systems with immediate access storage and remote input-output devices to provide a more integrated and effective system than heretofore.

(15) Representative depot maintenance systems now in existence and significant features being improved by the ALS are described below:[33]

(a) The Maintenance Engineering Management System (MEMS) which provided an initial approach to industrial management evolved from several systems that were processed on punch card accounting machines (PCAM) and were later converted to sequential type computers. It successfully furnished maintenance managers with mechanically produced planning, production cost, and accounting reports based on labor and materiel standards containing common data elements. Processing systems which were developed during this period and which are being refined further in the ALS are:

1. The Depot Automatic Rescheduling Technique (DART), implemented by 1965, provided a mechanized daily schedule and forecast which considered available resources and their sequencing and use in relation to the task. This system has proved highly effective in accomplishing major aircraft modification projects such as the vertical fin rework of several hundred KC-135 aircraft.

2. The Mechanized Engine Scheduling and Control System and the Routed Item Control System update capability for maintenance of equipment by use of the critical path planning method to produce a daily schedule and forecast that are constrained by available resources.

3. The Management of Items Subject to Repair (MISTR) System, implemented in 1965, is a method of managing the depot level repair of recoverable items. MISTR incorporates information concerning requirements, worldwide asset data, and distribution data. These data are obtained by interface with other logistics ADP systems. The MISTR system correlates these within a biweekly computation which provides management with visibility of the total worldwide stock level deficit. The deficit is then adjusted based on actual unserviceable items available for repair, resulting in a repair requirement by repair activity. Priorities are then applied to facilitate repair scheduling and application of available resources. MISTR is employed by all Air Materiel Areas (AMAs). AUTODIN is used to communicate data with other logistics systems and to transmit repair needs to the appropriate Specialized Repair Activities.

(16) Both manual and automated systems have been used to obtain effective materiel production management. Each system has contributed to this goal and has in turn revealed the need for further improvements. These needs are reflected in the following examples:

(a) The ALS Directorate of maintenance workload resource programming and planning system will provide a means of assessing depot maintenance capability to respond to System Support Manager (SSM) and Item Manager (IM) repair requirements on a more timely and valid basis. It will include a capability to simulate proposed changes in workload mix or assumption of new workloads to determine the impact of alternative solutions. It will measure planned against actual resource utilization, and planned against accomplished workload. Repair

[32] Headquarters, United States Air Force, Presentation to the Joint Logistics Review Board, The Air Force Maintenance System, 9 May 1969.

[33] U.S. Air Force, Advanced Logistic Systems Center, Advanced Logistics System Master Plan, Vol. II, Part 6, March 1968.

and modification requirements will be assessed periodically and on demand. Periodic assessments will coincide with the program, requirements, and budget cycle processing. The system will be operational daily with a maximum required response time of 4 hours.

(b) The ALS Directorate of Maintenance Workload Scheduling and Reporting System will automatically prepare production schedules and reschedule on demand. This will be accomplished through an on-line, real-time operation interfacing with eight other systems. Primary goals are quicker reaction and reduced depot shop flow times.

(c) The ALS Directorate of Materiel Management Production Management System will provide current, concurrent, and consistent program status much more responsively. The system will include actual schedules and production for aircraft, engines, repair parts, missiles, area support, and ground electronics. It can relate total depot requirements, from the Federal stock number level, to applicable mission design series of weapons and support system. (See Figure 43 for interface relationships between this and other systems.)

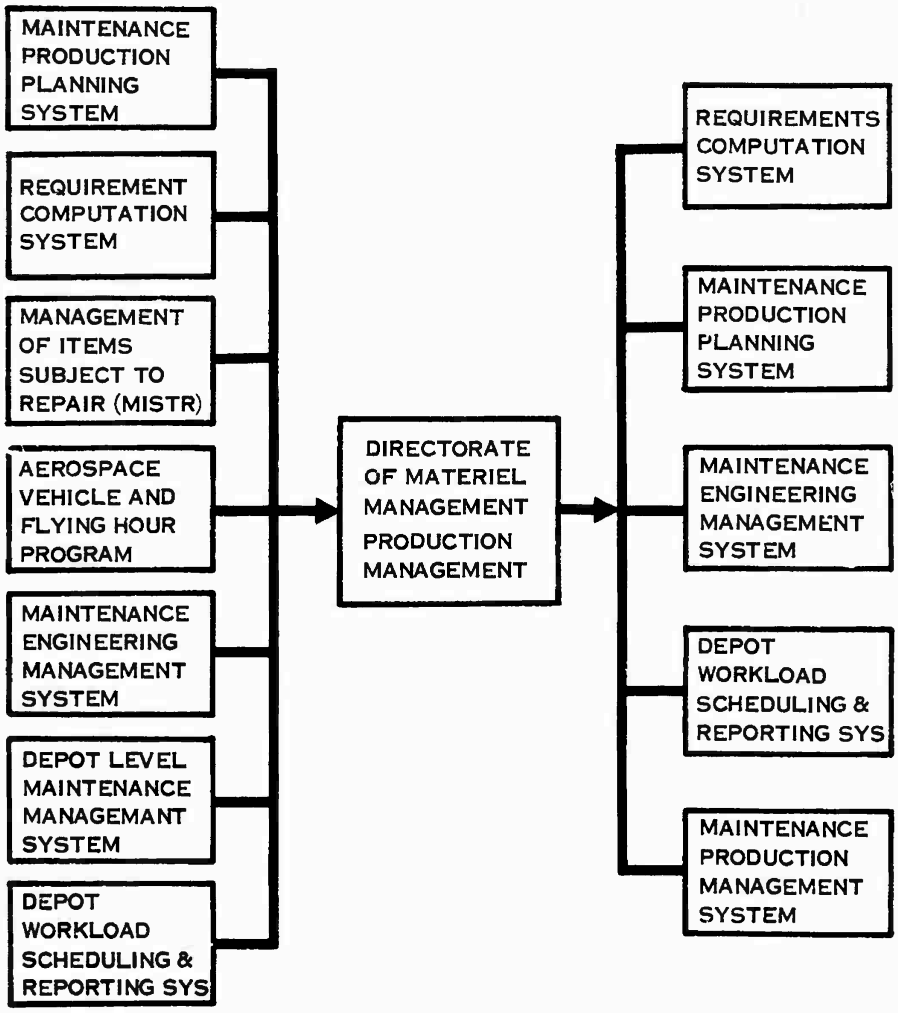

FIGURE 43. INTERFACE SCHEMATIC

(17) The ALS contains many significant features. However, of most significance is that ALS is more than an improvement to existing systems. It is a complete systems redesign tied to the total spectrum of wholesale support requirements.[34] The performance of depot maintenance will be advanced along with and in relation to other portions of the overall system in accordance with the master plan.

3. CONCLUSIONS

(a) Maintenance management information systems and operational readiness reporting were used extensively and enhanced maintenance effectiveness (paragraphs 2c(3), (4), (7), (11), (16), (17); 2d(2), (3), (5), (7), (8), (10), (13), (14); 2e(2)-(4), (6), (10), (12); and 2f(2)-(4), (6), (13), (15)).

(b) Advanced computer hardware and techniques now in existence will provide further improvements in maintenance management (paragraphs 2c(11), (14), (17); 2d(11), (14); 2e(9); and 2f(10), (11), (14), (16)).

(c) The evolution to standard systems collecting similar information for maintenance management increased during the Vietnam era (paragraphs 2c(3), (4); 2d(4), (7)-(10), (14); 2e(4), (10); and 2f(3), (4), (5), (8), (15)).

[34] Government Executive Magazine Article, The Advanced Logistic System, November 1969.

CHAPTER XII
REPARABLES

1. INTRODUCTION

a. Reparables constitute the largest dollar investment in the inventory of secondary items and generate a major workload in maintenance. The degree to which these components can be repaired and expeditiously returned to service reduces the financial burden and lead time problems of new procurement.

b. The Joint Army Materiel Command/Navy Material Command/Air Force Logistics Command Task Group for Supply Management Review reported on 29 May 1968 that the total DOD worldwide inventory, excluding real property, totals approximately $119 billion, and that the installed or in-use inventory will account for 65 percent of the amount, with the remaining 35 percent, which is presently in stock, amounting to $40 billion.[1] The study further develops that repair, as a source of resupply, will produce 30 percent to 75 percent of all resupply requirements for reparable items, depending upon the Service and commodity being reviewed.[2] If the minimum figure of 30 percent is applied against the $40 billion, a massive $12 billion is involved in reparables management. The best possible management techniques must be applied to this important segment of the DOD investment.

c. The scope and depth of visibility selected by a Service must be sufficient to permit management actions which are significant to the overall situation. The necessity for visibility and control of this nature becomes more pronounced in contingency situations such as SE Asia. There is little capability to perform repair of components in the forward area during early stages of a contingency. Facilities will not be in place. The proper balance of skilled personnel, test equipment, and technical publications is not likely to be readily available. Under these conditions a concept of forward operating locations using a remove-and-replace concept, and backed up by a rear echelon or CONUS repair location, becomes desirable. Rapid transportation, notably air transportation, reinforces the ability to evacuate reparables to secure areas which already have installed facilities and the matching skilled personnel and equipment. Experience has indicated there is considerable air transportation available for movement of retrograde cargo. Due to the little time required and the availability of transportation to move components to CONUS it is considered highly appropriate that repairs be performed in CONUS rather than utilizing offshore locations.

d. It has become routine for the Air Force to return recoverable assemblies by air from SE Asia to CONUS for repair. In fact, 43,908 items are coded for mandatory airlift and many others routinely utilize airlift as it is available. This takes on added significance when it is realized that transportation activities under pressure to move equipment and personnel into combat areas normally have space available for the return trip, and this can be used to return reparables. The effective return of reparables and the resupply of serviceable items as a complete system is a necessary prerequisite to reducing resources in-theater. The reduction possibilities are not limited to reparable components, but extend to repair parts, repair facilities, test equipment, and skilled personnel.

e. Air terminal facilities in support of airlift must be adequate to handle the flow of reparable items and return of serviceables. Congestion such as occurred on occasion in Vietnam can affect reparables as well as other air cargo. (See Transportation Monograph, Chapter III, Section E, Airlift.)

[1]Joint AMC/NMC/AFLC Task Group for Supply Management Review, Report of a Study on Inventory Control Point Asset Knowledge and Control of Secondary Items, 10 September 1968, p. 32.
[2]Ibid., p. 34.

f. In short, effective control of reparables requires total system visibility of a complete, closed loop processing system. The local manager charged with repair must have visibility over the items he is to repair. The item manager in CONUS must know the location and condition of selected reparables at all times if he is to schedule repairs and manage procurement of new components to meet mission requirements. This visibility must extend from the removal of a component attached to a major equipment item at unit level, through intervening levels, and on to ultimate repair or discard wherever this occurs.

g. A management and control mechanism of this nature is vital to develop system credibility. Confidence of operational commanders must be obtained in effectiveness of repair in rear areas or they will, in all likelihood, press for continuation of maximum forward repair, with all its attendant investment.

2. ANALYSIS. The extent and type of visibility now in effect varies among the Services. The Air Force uses a comprehensive closed loop system encompassing all levels of maintenance from unit to depot. The Navy system covers several levels, but with dissimilar systems and varying degrees of automation, and with an information gap between intermediate and depot levels. The Army system has gaps in visibility between levels and is the least automated. Marine Corps management of reparables is on a controlled item basis through a subsystem of the Marine Corps Unified Materiel Management System (MUMMS) and through naval aviation procedures. Each of the Service systems will be briefly addressed to provide a grasp of differences in visibility and control.

a. Air Force. The Air Force system, developed and refined during the Vietnam era, is an example of an effective reparables control mechanism. Three separate but interlocking applications of existing automatic data processing systems form the basis for the overall system and are described below. They are the Due in From Maintenance (DIFM) system; the Air Force Recoverable Assembly Management System (AFRAMS), and the Management of Items Subject to Repair (MISTR) system.

(1) Due in From Maintenance (DIFM) System

(a) The Due in From Maintenance (DIFM) system, established in the computer in March 1965, provides base maintenance and supply managers and CONUS inventory control points (ICPs) with visibility of reparable assets at base level as measured by time standards for repair, status of repair parts, return of reparables to CONUS and other factors.[3]

(b) At base level, the DIFM program ensures that intermediate level maintenance activities expedite the determination of whether or not items can be repaired at this level. For those items that can be repaired on base, the DIFM program provides visible evidence to managers of cases where repairs exceed time standards or where delinquencies exist in returning items to supply within established time limits. For those items determined to be beyond the repair capability of the base, the DIFM program contains time standards which require expeditious turn-in to supply for immediate shipment to a depot level activity where the items enter the Management of Items Subject to Repair (MISTR) system.

(c) The DIFM system constitutes a single integrated base level system which makes maintenance and supply equally responsible for control of reparable items through a series of closely coordinated efforts within a well defined procedural framework.

(d) When a demand for a repair cycle asset is received by Supply, the requester is provided a DIFM document number. This number provides the thread for processing continuity of the reparable component. The DIFM document number is coupled with demand data, replacement item identification, and other pertinent data elements to facilitate base level reparable scheduling. Checks and balances include a DIFM document suspense file to reveal any reparables not promptly entering repair channels.

[3]Air Force Manual 66-1, Maintenance Management, Chapter 3, 11 March 1968; Air Force Manual 67-1, Air Force Supply, Chapter 17, Part 1, Volume 2, 7 October 1968.

(e) Supply performs a daily reconciliation of DIFM documents 10 days old or older, with the suspense files located in the maintenance area. Each outstanding repair cycle asset must be identified as in-work, awaiting maintenance, awaiting parts, or work completed. The Chief of Maintenance is responsible for all repair cycle assets until they clear the supply DIFM file. Repair cycle items are returned to Supply for forwarding to the appropriate depot if the specified holding time periods have been exceeded.[4]

(f) A critical items list is maintained by Supply in coordination with maintenance, and is used to identify items for which valid or forecasted requirements exceed present or anticipated resources. This is generally a small number of items which could cause Not Operationally Ready—Supply (NORS) conditions to occur if not corrected. The critical items list is used to determine repair schedule priority. Information is also extracted from DIFM forms for use in computing base stock levels.

(g) Use of the Standard Base Level Supply System with its real-time computer and associated remote devices has established firm central control over base level inventory control functions, including current item location and condition status of repair cycle assets. It also provides the automated channel for transmission of DIFM information via AUTODIN into the AFRAMS system for worldwide visibility and management of reparables.

(2) The Air Force Recoverable Assembly Maintenance System (AFRAMS)

(a) The Air Force Recoverable Assembly Management System (AFRAMS), which began operating 1 November 1967, provides daily visibility to Inventory Control Points in CONUS on authorized levels of assets by condition and location.[5] (A recoverable assembly is defined as an item of materiel that loses its original identity during periods of use by incorporation into or attachment to a higher assembly or end item, and is subject to repair when unserviceable.)

(b) The system began operating on 1 November 1967 providing daily visibility of 77,000 items representing an investment of $5 billion. The system currently has been expanded to encompass some 163,000 line items with worldwide value exceeding $6 billion.[6]

(c) Establishment of AFRAMS involved modification to 31 existing materiel management systems and creation of eight new data system modules to capture required data, store it in usable form, and use it for improved performance. Maximum use is made of existing procedures and formats to minimize the impact on base activities; e.g., the Stock Balance and Consumption Report (SB&CR) data formats pertaining to assets, levels, and consumption are used in AFRAMS. The AFRAMS also uses appropriate data formats from the DOD Military Standard systems. Features of the eight new data system modules are given below.

1. The D143A module provides a master cross-reference and directory process to integrate existing data systems which cover item identification, cataloging, stock control data, standardization, and interchangeability and substitutability. This system provides a filter to purify and cross-reference part number, federal stock number, and changed numbers to a currently valid identification for all the items the Air Force uses, as registered with the Defense Logistics Service Center. This module processes at Hq AFLC weekly in sequence with the systems it ties together, and provides consistent, concurrent data to the D143B module at each AMA and to all Air Force bases. The D143B module at each AMA processes daily to provide editing, indexing, routing, and cross-referencing for all AFRAMS transactions and for the revised systems operating there.

2. The D143F module acts as the Consumption Data Bank and accumulates item activity history, by location, for the development of consumption factors by and in the requirements computation system at each AMA for their prime items. This module outputs

[4]Air Force Manual 67-1, Air Force Supply, Chapter 17, Part I, Volume 2, 7 October 1968.
[5]Air Force Logistics Command, The Directorate of Materiel Management, Oklahoma City Air Materiel Area Publication, 16 May 1969.
[6]Headquarters, Air Force Logistics Command, DO-41, Computation CSIS: Central Secondary Item Stratification Report, 31 December 1969.

quarterly complete item consumption data by location for use in levels computations and requirements projections.

3. The D143H is the Central Knowledge module. It operates at each of the five AMAs for the AMA prime items, and contains the authorized stock levels and assets by item location and condition. The data are updated by daily change reports from all activities involved. Each AMA has daily visibility of the assets and levels for all items in the system for which the AMA is prime. It passes daily to the appropriate inventory manager stock control and distribution system knowledge of base excesses to allow necessary redistribution action to be taken. A daily listing of the status of all critical items at or below the depot minimum reserve level is printed for the inventory manager's action. Base excesses, reparable, and Technical Order Compliance (TOC) quantities asset information are provided biweekly for repair scheduling. A monthly redistribution order effectiveness analysis is issued and total assets data are produced quarterly or on demand for requirements computations. This module also has the capability to respond daily to interrogations relating to item stock position and distribution.

4. The D143K module operates at each AMA with quantitative knowledge of XD assets moving from depot to base, base to base, and base to depot. It records, by Federal Stock Number and location, actions pertaining to in-transit shipments. Records are established and maintained from transactions incident to shipment and receipt of material reported by all Air Force activities. Availability of these data, when coupled with on-hand assets at all Air Force activities, provides the Air Force-wide asset position of Air Force owned items. The details available in this system also provide the source for development of actual pipeline time between Air Force locations. This module produces a daily mechanical output of changes in in-transit item quantities for D143H and a quarterly report of item pipeline times for the requirements computation system.

5. The D143L module is the Effectiveness Evaluation and Management Reports Control subsystem and is designed to provide current, concurrent, consistent, and integrated measures of AFRAMS control and overall cost/effectiveness of recoverable assemblies. Overall cost/effectiveness measures of logistic system performance under AFRAMS are based on validated requirements, e.g., acquisition, repair, and redistribution. Control reporting provides diagnostic capabilities for aid in the correction of problems in the various functional areas. This module extracts data from distribution requirements and other D143 systems at AMA level, and provides AMA level analyses as well as forwarding the data to Hq AFLC for processing in the command portion of this system.

6. The D143M module is the Logistics Item Transfer subsystem which operates at each AMA to control and expedite movement of mechanized records between AMAs when items are transferred.

7. The D143Z module is the Quarterly Stock Balance and Consumption Report Reconciliation subsystem which operates at AFLC and each AMA to compare assets, usage, and stock levels between AFRAMS and the Quarterly Stock Balance and Consumption Report.

(3) Management of Items Subject to Repair (MISTR) System

(a) The Management of Items Subject to Repair (MISTR) system was implemented in 1965, and is a method of managing the depot level repair of recoverable items. MISTR incorporates information concerning requirements, worldwide asset data, and distribution data. These data are obtained by interface with other logistic automatic data processing (ADP) systems. The MISTR system correlates these within a biweekly computation which provides management visibility of the total worldwide stock level deficit. The deficit is then adjusted in accordance with actual unserviceable items available for repair, resulting in a repair requirement by repair activity. The highest repair priority, precedence 1, is assigned for immediate due-out requirements in support of back orders. Priorities are thus applied to facilitate repair scheduling and application of available resources. MISTR is employed by all Air Materiel Areas. The MISTR system is highly automated, using advanced computer and data transmission techniques.

It is designed to provide a long-range projection of the logistic systems annual repair requirements for use in the preplanning and establishment of repair sources and a short-range projection of biweekly repair requirements requiring immediate repair.[7]

(b) The biweekly computation period was selected for optimum response to Air Force logistics requirements. Each two weeks, the system computes and updates the quantity of each recoverable item requiring repair during the next 4-week period based on current customer demands. The urgency of need for these requirements are identified by a repair precedence. During the first week, the repair requirement is computed and reviewed by the item manager and the requirement transmitted by (AUTODIN) to the designated Specialized Repair Activity (SRA). During the second week, the SRA AMA schedules the requirement and orders repair parts. During the third and fourth weeks, the SRA AMA produces the biweekly repair requirements. Reports reflecting the scheduling actions and production accomplishments are provided to management during and after the completion of each biweekly MISTR cycle.

(c) The following MISTR objectives provide further insight of system operation:

1. Compute short, intermediate and long-range depot stock level deficits based upon both historical and projected customer demands.

2. Determine that portion of the total deficit which may be replenished through application of depot and contract repair sources.

3. Selectively apply repair sources to the deficiency according to a definite priority of need.

4. Provide necessary tools to facilitate efficient internal depot repair scheduling through portrayal of asset and component availability.

5. Provide automatic requisitioning of current and longer range component part requirements.

6. Provide operating and management personnel with tools to monitor scheduling and repair progress through preparation and analysis of a complete range of management products.

7. Provide optimum communication channels and operating frequency between the customer and the repair activity.

(4) Summary. The Air Force combines three separate but interlocking applications of existing automatic data processing systems into an overall program which provides the item manager with worldwide closed loop visibility of selected reparables, including those undergoing repair and those in transit. The program has undergone refinement during the Vietnam era, and was recently expanded from 77,000 items to 163,000 items. This reparable control program provides effective assignment of priorities for repair, and efficient computation for new procurement.

b. Navy

(1) The Navy's depot level reparable inventory is managed by the Hardware Systems Commands and Inventory Control Points under the Naval Supply Systems Command. The vast majority of the depot reparables are secondary items managed by the ICPs.

(2) It is Navy policy to accomplish repair at the lowest practical level. The policy is implemented in part through item source, maintenance, and recoverability coding which

[7]Air Force Logistics Command Regulation 171-20, Management Reports, 25 September 1968.

specifically designates the lowest maintenance level authorized to perform repair. Additional coding identifies the highest level to which a component should be sent for repair.[8]

(3) The Navy employs a Uniform Inventory Control Point Program for monitoring carcass returns, developing carcass return forecasts, computing depot repair cycle time, and repair survival rates. The repair requirement is computed from these and other data. The product of this computation is the repair schedule which serves as the inventory manager's instructions to the overhaul activity as to priority and quantity to be repaired. The worldwide reparable Asset Reporting System is also used.

(4) In the High Value Item Management Program, the Navy applies intensified management to a small percentage of items which represent a significant portion of annual procurement dollar expenditures. This is presently applicable to about 9,000 items. For these items, asset reporting procedures are extended to designated fleet and shore activities outside the normal asset reporting system. Activities involved are tenders and repair ships, fleet issue ships, aircraft carriers, and nonreporting stock points ashore. These units provide the inventory manager with a monthly status of all high value asset control items and an audit trail of all transactions occurring between the monthly reports.

(5) Navy inventory control points also employ specialized systems for obtaining visibility of assets outside of the normal reporting system. Monthly reports are rendered by contractors engaged in depot-level repair of reparables to all ICPs. The Electronics Supply Office has a Critical Item Reporting procedure under which special reports are provided on items essential to operational readiness which are in short supply or are expected to be in short supply due to procurement lead time. The Aviation Supply Office maintains a reporting system for Support Equipment covering those items in store and in-use. In FY 66, this system covered 4,268 items valued at $880 million. By 31 March 1969, this system had been expanded to cover 6,500 items valued at $973 million.[9]

(6) In August 1968, the Aviation Supply Office instituted a program for obtaining worldwide visibility of all depot level reparables. This program extended quarterly reporting to 29 additional CONUS activities, 17 extra-CONUS activities, 31 ships supporting aircraft and 16 Fleet Marine Force units supporting aircraft. The objectives of this program were to obtain additional visibility for purposes of filling backorders, assisting in budgetary and procurement computations, and identifying excessive maintenance float quantities.

(7) The Navy encountered difficulties in the management of depot reparables during the Vietnam era. Problems included poor documentation and identification. Navy improvement task groups, including the Inspector General Supply Corps Reports, showed that as much as 20 percent of the reparables required reidentification at the repair facility. Inventory discrepancies also posed a problem. Assets reported to inventory managers were found to be in error by 20 to 25 percent.[10]

(8) In 1968, the General Accounting Office reviewed the Navy's program for repair of electronic components and assemblies managed by the Electronics Supply Office (ESO), Great Lakes, Illinois, to determine the adequacy of controls and the extent to which items were being repaired rather than procured to meet supply system needs. The General Accounting Office report[11] stated that "weakness in the management control of the Navy's repair program for electronic items had compromised the program as a source of supply and had resulted in the unnecessary procurement of new items." The GAO found that appropriate consideration was not given to repair as an alternative to procurement of new items; adequate technical data regarding item reparability or repair source were not available; there was little coordination between ESO and

[8] Office of The Chief of Naval Operations, Service Headquarters Briefing, 15 October 1969.

[9] Deputy Chief of Naval Operations (Logistics) Memorandum, subject: Item Visibility, 3 November 1969.

[10] Naval Supply Systems Command, Letter, subject: Navy Aeronautical and Electronic Repairable Program, 10 November 1966.

[11] The General Accounting Office (GAO), Department of the Navy, Navy reply to GAO Draft Report of September 1968, 8 November 1968.

the repair facilities; and timely action was not taken to required field activities to send unserviceable items to the repair facilities.

(9) The GAO recommended that ESO coordinate with other activities in identifying reparable items and repair sources, and that Department of Navy oversee the prompt implementation of corrective measures necessary for an efficient and effective repair program. Reparables management has been established by departmental instructions and responsibility over implementation of the instructions is at the departmental level. NAVMAT 4400.14 assigns command responsibility for monitoring the discharge of responsibilities assigned by the instructions. Quarterly progress reports are required from the System Commands and the Project Managers.

(10) The Navy is developing both short and long range policies for the management of depot reparables. These policies are to be promulgated in a NAVMAT Reparables Management Manual and will provide instructions on repair budgeting and forecasting, repair scheduling, retrograde movement, asset visibility, repair parts support, and pool management. With this manual, the Navy hopes to accomplish two major goals:

(a) Promulgation of the latest and best thinking in reparables management techniques.

(b) Shorten the lead time between conception and prosecution of changes.

(11) The Navy is developing further improvements in depot processing and information feedback for repair scheduling. This will make it possible for all Navy inventory managers and overhaul points to schedule and induct weekly as is being done today by the Aviation Supply Office and the Naval Air Rework Facilities with the NICRSP System, which performs similar functions to those performed by the Air Force MISTR System. One feature of the program will be a depot feedback information system which will, in addition to reporting inductions and completions, report such constraints as capacity and capability limiters and will include quantities, dates, and reasons for the deficiency.

(12) The current Navy system and improvements now being developed for visibility and control of reparable assets represent an important step forward. However, variation still exists between the Aviation Supply Office (ASO), the Electronics Supply Office (ESO), and the Ships Parts Control Center (SPCC) in scope and depth of coverage, and in reporting frequency. For example, ASO reporting is quarterly and covers all depot reparables from all users with significant assets,[12] while SPCC has daily visibility at reporting activities, but would like visibility of all depot reparable items.[13]

(13) Reparables information generated under the Naval Aviation Maintenance and Material Management (3M) system by use of the DIFM Job Control Number and related procedures is not directly linked to the supply system at either base level or depot level. Therefore, the item manager does not have full visibility of components undergoing repair at base level. This link would facilitate reparables management and effectiveness of depot repair scheduling by such systems as the ASO NICRSP.

(14) In summary, current Navy systems encompass many necessary elements for effective reparables control, but could be enhanced by their further incorporation within an overall framework, tying together different systems now operating for similar purposes but which vary in responsiveness or depth and scope of coverage. Extended use of automation for recurring control stations should be possible by modification to existing ADP systems, and provide the benefits of a more uniform Navy-wide system for control of reparables.

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[12] U.S. Navy Aviation Supply Office, Briefing to the Joint Logistics Review Board, Visibility of Assets, 18 August 1969.

[13] U.S. Navy Ships Parts Control Center, Briefing to the Joint Logistics Review Board, Asset Visibility, 22 August 1969.

c. Army

(1) It is the Department of the Army policy that unserviceable components removed from equipment during maintenance be repaired, evacuated, or otherwise disposed of in accordance with the source, maintenance, and recoverability codes assigned to the items. This policy fixes responsibility on the using unit to turn in reparables which are replaced with serviceable units. Reparable components as well as the level of maintenance authorized to accomplish repair or the elimination from the system of uneconomically reparable parts are identified for the user in technical manuals, supply catalogs, and the Army Master Data File as the repair parts source, maintenance, and recoverability code. These codes are assigned each item of supply. Condition codes are assigned to unserviceable items to identify the degree of unserviceability.

(2) Unserviceable reparables are returned to the supply system by one of three procedures at the unit level:

(a) Direct Exchange Procedures. The procedures provide for material to be exchanged on an item for item basis and apply between the user level and the Direct Support (DS) or General Support (GS) level. Requisitioning by the using unit is not required. A list of items that can be exchanged on this basis is published locally by each DS/GS unit. The Army experienced problems in this area from the untimely repair of these unserviceable items by the direct exchange activity. Furthermore, the supply records do not adequately record the situation at the exchange activity. This stems in part from the fact that The Army Equipment Record System (TAERS) TM 38-750 does not record enough information to control reparables at the intermediate level nor relate them to the issue of replacements. The Army instituted the Return of Army Reparables (ROARS) program at field level to reduce the return problem. Further, the management and control of reparable items between the using unit and direct support or general support activities has been improved by providing stock accounting machines (NCR 500) to record the multiple transactions as reparables move from units to repair and back into stock.

(b) Automatic Return Lists. This procedure requires each ICP to publish a list of intensively managed items on a quarterly schedule. These are items of high dollar value or items that are in a critical supply posture. Items listed are authorized direct return to CONUS depots and repair facilities without the necessity of going through the normal reporting procedures.

(c) Excess Procedures. These procedures provide that items excess to the requirements of the holding activity be reported to the theater or CONUS Inventory Control Point (ICP) for disposition. It includes unserviceable items as well as serviceable items. The quantity and condition of the items are reported through channels to the ICP and formal disposition instructions are provided on an item basis.

(3) The ICPs participate in developing depot repair programs by using the intelligence gathered through the system described above and other available program data. The first step in this program is the development of unserviceable return forecasts which are accomplished by developing a ratio of unserviceable returns to issues during a base period and then applying that ratio to forecasted issues. The forecast of issues recognizes changes in end-item population, flying hour programs, mileage programs or other factors which would effect future demands. Within the budget guidance provided, the rebuild program is established through a series of rebuild conferences held in advance of the target year. The DA, AMC, Depot Maintenance Control Center, and ICPs participate in developing a final program. The next step is the determination of support parts requirements and the procurement of the required materiel. This is followed by the actual repair actions and the return of the repaired items to stock.

(4) The procedure for developing the repair program has remained basically the same since January 1965; a number of refinements have been made which enhance the ICP's capability to more accurately forecast unserviceable returns. These refinements are the establishment of:

(a) A Critical and Intensive Managed Items List. These ICP lists of items are published quarterly in supply letters and distributed to all echelons of supply. Included are those items requiring intensive management and the automatic return of serviceable excesses and unserviceable depot reparable items. The lists also indicate the repair facility to which the unserviceables should be returned.

(b) OASIS. This program provides for CONUS ICP ownership of selected high value items stored in overseas depots. The daily transaction reports from the overseas inventory control centers (excluding Vietnam) enable prompt recognition of unserviceables and ensure their expedited return to the repair facility.

(c) Closed Loop Support. This special management procedure consists of command and support elements employed in a closely controlled network to ensure improved supply support. Logistic functions such as supply, retrograde, overhaul, and return to Army supply channels are arrayed in a detailed schedule to provide a means for ensuring that critical major items and major assemblies are expedited to overhaul facilities and returned to the command if required. The Closed Loop Support (CLS) program has resulted in considerable improvement for items in the program.

(5) Current Army systems have minimized former problems in some areas. However, the return of reparables from the using units to the depot maintenancy activities continues to present a problem. In a report[14] by The Comptroller General of The United States, the General Accounting Office concluded that:

(a) Although Army regulations are basically sound in providing for the recovery of items that can be economically repaired and reused, the implementation of these regulations has been weak in a number of instances at both the ICP level and the installation levels. The principal weakness at the ICP level appears to have been a lack of procedures to ensure correctness and consistency of coding in publications used by Army installations to determine recoverability.

(b) At the installation level, the supply activities appeared to lack sufficient authority to enforce the turn-in of reparable items, although they are the logical organizations to effect such recoveries. As a result, these activities had generally not adopted a policy of performing adequate follow-up to ensure receipt of a reparable item when a serviceable item was issued as a replacement. Such a policy, with or without directional authority, could substantially improve the rate of recoveries and minimize overstocking by using maintenance activities.

(c) A substantial increase in the recovery rate could significantly reduce the need for costly new procurements. This opinion is based on the following facts:

1. Only about 30 percent of the reparable items included in the test were actually turned in by the using units.

2. Procurements on some of the items that were not recovered have been significant.

3. Unserviceable items are generally repaired at substantially less cost than the cost to procure new assets.

(6) In a subsequent report[15] the GAO pointed out that "a comparison of issues and returns of 64 repairable items during a 6-month period disclosed shortages of returns valued at about $8 million for 38 of the items." The GAO also recommended that increased emphasis be given to the control of reparables.

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[14]General Accounting Office, Report B146874, Need For Improvement in The Army Supply System to En. The Recovery of Repairable Spare Parts, 23 January 1968.

[15]General Accounting Office, Report B-160763, Need To Improve Management of Army Supplies in Vietnam, 21 June 1968.

(7) Even more recently, the GAO completed a review of the supply system in the Far East, and again examined the effectiveness of the control over reparable items. Of 68 reparable items during a 6-month period ending on February 28, 1969, there were shortages of returns valued over $22 million for 52 of the items. For example, during the 6-month period, the Army's Aviation Materiel Management Agency in Vietnam had issued 707 tail rotor assemblies having a unit price of about $16,410 for the OH6A (CAYUSE) helicopter and had received returns of only 390 of these assemblies. More than $5 million of unserviceable units had not been turned in for repair. Likewise, at the Long Binh Army Depot, our comparisons for 6 diesel vehicle engines having unit prices ranging from $2,860 to $18,000 disclosed that issues exceeded returns by 1,167 units which had a total value of $4.2 million. The GAO concluded that the significant difference between issues and returns indicate there is still a potential for improving management control over reparable items.[16]

(8) The Closed Loop Support and OASIS programs are noteworthy examples of Army recognition of the problem and a step toward solution. However, they operate on a small scale in relation to the overall problem, as CLS covers only 53 secondary items, OASIS covers 1034 prime items and 843 substitute items, and the Central Asset Visibility and Management Program for USARV (CAVAMP), which is specifically for Vietnam, covers 2,132 items. The basic problem appears to be a lack of significant information continuity from the point of direct exchange at unit level, through TAERS, CLS, and other reporting into the depot repair system and back again to unit level. For example, there is no control system at DS/GS level to manage items undergoing repair, such as is provided by the Air Force DIFM control number and the Navy Job Control Number. Lack of this type information also deprives the item manager of a significant control element.

(9) The Army system for reparables management could be strengthened by more positive control at DS/GS level, with new procedures specifically designed for reparables, including cross-feed of information from maintenance into supply systems using a Job Control Number, and subsequent transfer of pertinent information into depot channels for priority scheduling and accomplishment of maintenance at that level.

(10) Further use of ADP systems could provide more effective reparables management through use of such techniques as automatic identification and tracking of items processed under CLS, CAVAMP, and OASIS, and by use of automatic data processing equipment (ADPE) to routinely relate different authorized stock numbers to an equipment item.

(11) In summary, the Army system for reparables management contains several procedures and programs for tighter control under special circumstances. However, these are on a relatively small scale, do not make extensive use of automation, and are not fully interfaced between maintenance levels and between systems. Existing systems could be expanded and interfaced, and ADP supporting systems modified to provide control on a larger scope and depth, and to reduce problem areas identified by the GAO and others.

d. Marine Corps

(1) The Marine Corps secondary items reparable program was established in April 1965. It includes items in the supply system of a durable nature that are economically restorable to a serviceable condition but which do not meet the criteria established for assignment as a principal end item. Non-depot reparable items are those which can be repaired below the depot level. Marine Corps' policy provides that repair of secondary items be accomplished at the lowest maintenance echelon authorized to repair an unserviceable. The Inventory Control Point is the manager of the secondary items depot reparable program and has worldwide asset visibility of secondary reparable items, including those items in Fleet Marine Force floats. By means of allowance lists, the ICP gains total requirement visibility (see Supply Management Monograph, Chapter V, Item Visibility).

[16] Mr. C. M. Bailey, General Accounting Office, Statement Before the Subcommittee on Military Operations of the Government Operations Committee, House of Representatives, U.S. Congress, 20 November 1969.

(2) Although the program was established in 1965, a major overhaul and reorganization were performed in 1967 to satisfy increased requirements generated by the Vietnam action.

(a) The size of the annual reparable program increased from $6,554,000 in FY 66 to $33,343,540 in FY 69. This investment in secondary reparable items is reflected in the existing inventory and the increased maintenance floats.

(b) In March 1967, Project DEP REP initiated a measurement test for the April 1967 to April 1968 period to determine the retrograde time in shipment and evaluate quantities and types of secondary items being evacuated. This test stimulated the movement of secondary reparable items to the supply centers for final disposition based on repair or discard evaluations.

(3) Marine Corps aviation follows Navy procedures which are described in Navy, paragraph 2b of this chapter.

(4) In summary, the Marine Corps secondary reparable program was established in 1965 and revised in 1967 to improve response to Marine Corps requirements. The system provides for serviceable assets being directly available to the user. This is accomplished through an exchange of serviceable assets, movement of the unserviceable assets to designated maintenance activities, repair/rebuild through a series of maintenance programs, and return of the serviceable asset to the stores system or washout (unrepairable) at the depot level. The result is directed toward minimal investment costs for replacing only those items washed out at the depot maintenance level. Positive management attention was given to this important facet of materiel management for proper utilization of available resources during the Vietnam era.

3. OVERVIEW

a. Reparables processing constitutes a large and significant aspect of logistics, with a minimum annual financial impact of $12 billion. It is essential for each Service to operate management information systems which provide reparable visibility of a sufficient depth, scope, and timeliness to permit effective control of these important assets.

b. In contingency situations such as Vietnam, the supply of serviceables and controlled return of retrograde items can reduce the inventory needed in-country. The lack of forward area repair capability during initial stages of a contingency situation will probably dictate the return of reparables if they are to be repaired within a reasonable time frame.

c. Airlift provides rapid transportation for returning most components to CONUS for repair.

d. Effective operation of such a system will gain the confidence and cooperation of operational commanders, which is essential to the efficiency of any system.

e. Considerable variation is evident in control exercised by the Services, with most control by the Air Force and least by the Army. All seem to recognize the goal of total system visibility from reparable removal to ultimate repair, and the relationship of this to new procurement. However, current scope of visibility varies from a few thousand components in the Army to over 160,000 in the Air Force.

f. The need for increased visibility and control has been the subject of several studies and reports, notably by the General Accounting Office. While improvements are possible by all Services, the Air Force has received the least criticism, apparently because it has devised a successful reparable control program during the Vietnam era. This program integrates three systems into an overall effective control mechanism. These systems are the Due in From Maintenance (DIFM) system which captures base level information, the Air Force Recoverable Assembly Management System (AFRAMS) which is the information processing system for appropriate managers, and the Management of Items Subject to Repair (MISTR) system which establishes priorities and schedules depot repair. These systems have been briefly described as an example of the type of control which is desirable.

4. CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

(1) Visibility must include sufficient asset knowledge to ensure that each Service can have an effective and efficient reparable program at all levels and can fully integrate the reparable information with procurement of new components to meet requirements (paragraphs 1g, 2a, 2b(6) and (8)-(14), 2c(1) and (4)-(11), 2d (2), and 3a).

(2) Reparable control systems can enhance logistic support during initial periods of contingency situations when little in-country repair capability is available (paragraphs 1d and 3b).

(3) Effective reparable control systems can reduce in-country investment costs for inventory, facilities, test equipment, and skilled repair personnel (paragraphs 1d and e).

(4) Reparable control systems should make appropriate use of air transportation to reduce pipeline time and permit further reduction of in-country investment (paragraphs 1d and e, and 3c).

(5) Air terminal facilities to accommodate the reparable flow should be provided (paragraph 1f).

(6) The Air Force reparables control system is the most comprehensive in coverage and makes extensive use of automation to provide total system visibility from unit replacement level through depot repair and back to unit level (paragraphs 2, 2a, 2b(4)-(5) and (14), 2c(8) and (11), 3e, and 3f).

b. Recommendations. The Board recommends that:

(MT-17) Each Service develop and refine reparable control systems for selected components which will:

(a) Ensure that, from the time of removal from a major end item, the location and status of each component is known at the proper management levels until it is repaired and returned to service or condemned and dropped for disposal.

(b) Make appropriate use of air transportation for movement of reparables (conclusions (1)-(5)).

CHAPTER XIII
SUMMARY

1. OVERVIEW

a. Measured in personnel and dollar costs, maintenance is the major functional element of Department of Defense logistics. The weapon system and equipment readiness posture of the Armed Forces depends on maintenance support in the combat area, offshore, and in the continental United States (CONUS). That effective maintenance and responsive systems existed in the Services was attested to by the high equipment operational ready rates attained in Southeast Asia. However, Vietnam experience reaffirmed the fact that responsive maintenance procedures alone will not suffice. In-being maintenance units are essential to provide support in the early phases of combat operations. The accomplishments of maintenance personnel were highly creditable, but there were major problems, especially in the early days of the conflict. The Southeast Asia environment, combining abrasive sand with heat and humidity, increased the need for maintenance. In addition, because of the interrelation with the functions of supply management and transportation (see monographs), initial difficulties in receiving, identifying, warehousing, and issuing spares and repair parts had an adverse impact on the maintenance function.

b. Availability and utilization of trained maintenance personnel varied among the Services because of differences in mission, organization, and ratio of military to civilian billets, as well as special situations that developed during the conflict. Each of the Services experienced military personnel turbulence as a result of rotation policies and assignment practices and all were required to draw down personnel from units not directly involved in Southeast Asia.

(1) The Army, unlike the other Services, was substantially manned with 2-year draftees and 3-year first term enlistees. Further, many of the Army's intermediate and depot level maintenance activities were highly civilianized. The combination of these two factors restricted the Army in providing adequate practical training prior to deployment and necessitated a reliance on augmentation with contract maintenance personnel at intermediate and depot maintenance levels. The Army's maintenance problems were further complicated by the introduction, beginning in late 1966, of the Combat Support To The Army (COSTAR) organizational concept. This concept, not adequately field tested, resulted in a reorganization from technical service oriented maintenance units to functionalized maintenance organizations. An evaluation, completed in June 1968, revealed that nondivisional direct support maintenance organizations did not have the required personnel and skills to perform maintenance and supply functions for all equipments of field Army units.

(2) Incentives were lacking for high quality U.S. civilian employees to accept overseas employment. This was particularly evident at the Navy's Western Pacific (WESTPAC) Ship Repair Facilities and constrained the supervision and training of indigenous workers. In addition, problems were experienced at CONUS Naval Shipyards, Naval Aircraft Rework Facilities, and Air Force Air Materiel Areas as a result of civilian personnel ceilings and overtime limitations.

c. The existence of a maintenance capability at offshore bases enabled all Services to respond effectively to the Vietnam contingency. The Army and Marine Corps found it expedient to convert offshore intermediate repair capabilities to limited depot level maintenance. The Navy's WESTPAC Ship Repair Facilities provided depot level maintenance support for the fleet, accomplished activations and conversions for ships and craft for service in Vietnam, and provided direct in-country maintenance support. Further, Navy experience demonstrated the value of the Advanced Base Facility Component System through its contribution for the early establishment of fixed and mobile facilities in Vietnam for the repair of boats and craft. The Air Force, in consonance with its mobility concepts, first used offshore bases to provide an intermediate maintenance capability and later, with contract maintenance, provided some depot level capability. In the continental United States, each Service had a responsive organic depot capability that was used effectively to meet the increased maintenance requirements created during the Vietnam era. These installations constituted both a facility and a manpower resource. Repair teams were used to extend depot level maintenance support to combat activities in Southeast Asia. The success of this program was largely due to the skills these personnel developed in depots working on the same weapon systems that needed repair in the combat theater.

d. All Services operated under the policy of repair at the lowest possible organizational level. This policy was essential in some cases, such as sustaining operations of the fleet at sea, and did result in high readiness rates. On the other hand, application of this policy in Vietnam generated requirements for wide ranges of spares and repair parts, extensive facility development, and extensive support equipment and personnel. For example, the Air Force constructed air bases in Vietnam and Thailand that included the full range of intermediate maintenance facilities in each complex. The magnitude of in-country resources required to support the forward maintenance policy suggested the possibility of reducing total resource costs by reorienting the policy to perform less maintenance in-country and to increase the use of offshore and CONUS intermediate and depot facilities. In 1969, the Air Force revised its basic policy from maximum base self-sufficiency to one of optimum repair; and the Army, in its Maintenance Support Positive program, is modifying its traditional "as far forward as possible" policy to better utilize maintenance resources through replacement of components and modules. Repair level policies must, of course, be reflected in the early design and development phase of the weapon system life cycle. A disciplined approach to the consideration of the impact of such factors as reliability and maintainability on maintenance was developed during the 1965 to 1970 period and documented in DOD Guide 4100.35G, Integrated Logistic Support (ILS) Planning. In this regard, Vietnam experience again demonstrated the need for a greater tolerance for abuse in equipment selected for operational use.

e. All Services refined their management systems in support of maintenance during the Vietnam conflict. Some of these changes were made in response to an urgent need whereas others were evolutionary in nature. The Army intensified its management of critical components, assemblies, and major items, and expedited the handling of essential repair parts through implementation of the Closed Loop Support and Red Ball Express systems. The Navy benefited from increased application of the Standard Maintenance and Material Management (3M) system for aircraft and ships. The Marine Corps obtained improved asset visibility and readiness reporting through the implementation of the Marine Corps Unified Materiel Management (MUMMS) and Automated Readiness Evaluation (MARES) systems and also found it necessary to expand organization maintenance capabilities, modify controls, expedite supply actions, and introduce new equipment to achieve higher equipment readiness rates. The Air Force recognized the need for better visibility and tighter management of reparable assets at all levels. The necessary controls were achieved by means of three interlocking automatic data processing programs developed or refined during the Vietnam era.

f. The preceding paragraphs summarize the more important aspects of maintenance operations as they evolved in Southeast Asia. One key maintenance consideration, work that was deferred because of funding constraints or that will be required to rehabilitate equipment returned from SE Asia, will have its major impact in the future. This subject, the major lessons learned, and the most important 8 of the 17 recommendations developed within the monograph are addressed in the balance of this chapter. It should be noted that the lessons learned and recommendations developed through analyses of individual Services are, in the opinion of the Board, generally applicable to all Services.

2. ARMY MAINTENANCE

a. Lessons Learned

(1) To overcome high deadline rates for certain types of equipment, the Army found it necessary to implement the Red Ball Express system in December 1965. This was a special supply and transportation procedure designed to expedite delivery of repair parts. Principal features of the system included direct submission of requirements to the Logistics Control

Office, Pacific; rapid transmission of requisitions to supply source; and priority airlift to Vietnam. Since its inception a significant reduction in Not Operationally Ready—Supply (NORS) rates has been accomplished with an increase in equipment availability rates. The need for similar specialized logistics systems can be expected in future conflicts.

(2) Careful planning and programming was required to maintain a balance between equipment requirements and repair part availability. To improve the logistical support to military forces in Vietnam, the Closed Loop Support System was initiated in November 1966. In this system the functions of supply, maintenance, and retrograde were integrated to ensure that critical items were directed to specific customers at the appropriate time and that unserviceables were retrograded to designated repair and overhaul agencies. The effectiveness of the Closed Loop Support system was demonstrated by its ability to meet program requirements on a line-item basis. The strengths of the Closed Loop Support system should be retained and reflected in future logistics systems.

(3) As the rate of deployment of combat and logistic units into Vietnam increased in 1966, the maintenance capacity, in terms of military maintenance organizations, could not keep up with the rapidly increasing workload. The shortage of military personnel at the intermediate level, caused by an inadequate CONUS military rotational base and the decision not to call up Reserves and the establishment of strict military ceilings, gave rise to the extensive use of contract maintenance. There is a need for establishing an adequately structured CONUS rotation base so that contract maintenance support can be held to a minimum. However, some use of contractor support should be anticipated and reflected in logistics planning as appropriate.

b. Recommendation

(MT-3) The Services be specific in their planning on the necessity for contract maintenance personnel to augment an existing organic maintenance capability. Where contract maintenance augmentation is required, plans should address the following factors:

(a) The size of the contractor force to be utilized.

(b) The number of contractor firms proposed for employment.

(c) Geographical locations proposed for assignment of maintenance contractors.

3. NAVY MAINTENANCE

a. Lessons Learned

(1) Sustained combat operations in Southeast Asia again demonstrated the requirement for individual ships to have maintenance and repair self-sufficiency, as well as the importance of the mobile repair capability represented by tenders, floating drydocks, and repair ships in remote areas.

(2) The Western Pacific ships and aircraft depot level repair facilities that were capable of expansion proved invaluable during the Vietnam era. They reduced the time ships and aircraft were off the line and minimized the cost of repairs.

(3) Airliftable mobile maintenance vans included in the Short Airfield for Tactical Support (SATS) system facilitated the prompt establishment of an organizational and intermediate level maintenance capability. Specially outfitted mobile vans proved their value also in the Philippines.

(4) When the buildup commenced, the Navy lacked sufficient maintenance support ships and craft in the active fleet to meet expanding Southeast Asia requirements. The use of ships and craft from the inactive fleet enabled the establishment of mobile in-country maintenance bases and augmentation of shorebased industrial facilities earlier than would have

been possible. Their use emphasized the importance of retaining selective assets left over from prior wars.

4. MARINE CORPS MAINTENANCE

a. Lessons Learned

A significant strength of the Marine Corps maintenance system was in its in-being structure of maintenance billets, manned at all echelons with military personnel from organization through depot level, which provided an adequate rotation base and which operated the same in peacetime as in wartime. The rapid and flexible structuring of maintenance support units was facilitated by the existing Marine Corps maintenance system, and was tailored to meet the equipment readiness requirements of supported combat units. A continuing high degree of equipment readiness resulted from this effective distribution of the maintenance workload. In recognition of the satisfactory Marine Corps experience in balanced civilian-military manning, the other Services in their decision of personnel allocation should give full recognition to the requirement for trained and skilled military maintenance personnel to meet maintenance demands when operational forces are first deployed.

5. AIR FORCE MAINTENANCE

a. Lessons Learned

(1) The Air Force concepts of utilizing in-being forces deployed to forward operating bases during the initial stages of a contingency again worked well in Vietnam. The integration of the supply, maintenance, and transportation functions of the Air Force logistics systems, refined during the Vietnam era, proved its worth by supporting greatly increased flying hour programs during the Vietnam era with low Not Operationally Ready—Supply (NORS) and Not Operationally Ready for Maintenance (NORM) rates.

(2) The Air Force recognized the need for better visibility and control of reparable assets. This was achieved during the Vietnam era through implementation of three interlocking management systems, Due in From Maintenance (DIFM), the Management of Items Subject to Repair (MISTR), and the Air Force Recoverable Assembly Management System (AFRAMS).

(3) The Air Force deployed its units to Southeast Asia under the maximum base self-sufficiency maintenance concept, which dictated a requirement for the same type of equipment, facilities, skills, and extensive supply support in-theater as existed in the CONUS. Mobility concepts permitted rapid deployment and employment of Air Force combat units in Southeast Asia, but these deployments were hindered by the large amount of maintenance support personnel and equipment needed to carry out maximum base self-sufficiency maintenance. The Air Force recognized this problem and took two basic corrective actions. First, the maximum base self-sufficiency maintenance concept was revised to one of optimum repair to achieve a better balance between base and depot repair. Second, the Air Force began to develop and test the concept, as demonstrated by CORONET BARE, that mobility can be enhanced through design and use of lightweight equipment and relocatable, reusable, modular facilities.

b. Recommendation

(MT-7) The Services, in order to maintain operational effectiveness but reduce to the maximum extent possible the requirement for personnel skills, equipment, facilities, and supplies in forward operating locations and bases, review on an item-by-item basis their decisions on where and at what level an item should be repaired.

6. DEFERRED MAINTENANCE

a. Lessons Learned

Deferred maintenance did not impair Service responsiveness to Southeast Asia requirements, but it did affect units not actively engaged in priority missions in support of combat operations. The inability to precisely predict the impact and cost of maintenance deferrals prevented supportable reclama for full resource support. Each Service may soon be faced with the prospect of inspecting and rehabilitating, as necessary, equipment being returned from Southeast Asia. The lack of adequate maintenance workload data, which has inhibited the Services' past ability to make optimal maintenance deferral decisions, will affect planning for the rehabilitation of equipment returned from Southeast Asia.

b. Recommendation

(MT-10) Service deferred maintenance be stratified to identify those hard-core requirements for support of readiness objectives and the segments of deferred maintenance requirements, including those not in hard-core requirements, where there is a clear indication that a significant adverse impact will result from further deferral.

7. MAINTENANCE SUPPORT CONSIDERATIONS DURING CONCEPT AND DEVELOPMENT

a. Lessons Learned

The DOD Guide 4100.35G, Integrated Logistic Support, presents many valuable concepts but does not adequately address the repair level decisions. The interaction of operational and economic considerations combined with equipment characteristics determines the manner in which equipment will be supported and the degree of repair to be performed at each level of maintenance. It has been demonstrated that the impact of maintenance support considerations on initial provisioning costs and support costs throughout the operational life of the equipment is of such magnitude that decisions must be made early in the development phase of a weapon system. This is when significant tradeoffs can be made to minimize life cycle support costs. Repair level decisions must be made on an item-by-item basis as early as possible in the development phase. This activity must be identified as a separate but integrated element of support planning.

b. Recommendation

(MT-11) The Office of the Secretary of Defense amend the Integrated Logistic Support Planning Guide (DOD 4100.35G) to include a defined element entitled Repair Level Decision.

8. DEPOT MAINTENANCE

a. Lessons Learned

The depot level maintenance capability of the military services provided the responsive capability required to support essential and urgent workloads during the Vietnam era. Contract maintenance was also used but was less responsive in many instances than organic activities. The organic capacity was increased by the limited use of overtime, when authorized, but total manpower was limited by ceiling controls. The effect was to place more work out to contract.

b. Recommendations

(MT-15) In recognition of the essentiality of a viable and responsive depot maintenance capability, the Services and the Office of the Secretary of Defense take steps to achieve a reasonably stable posture in their organic depot maintenance structure in the continental United States.

(MT-16) The Secretary of Defense continue to exclude industrially funded activities from overtime limitations.

9. REPARABLES

a. Lessons Learned

Vietnam experience again demonstrated that reparables are an important and costly part of logistics support and that effective reparables management can increase equipment availability and reduce new procurement. It was shown that effective reparables management requires a system that will provide the status of items undergoing or awaiting repair, ensure prompt retrograde of items not locally reparable, facilitate the expeditious intermediate or depot level repair of these items, reduce new procurement to the maximum extent possible, and provide sufficient asset visibility to the inventory manager to redistribute assets consistent with worldwide Service requirements. Further, appropriate use should be made of air transportation to return reparables to repair facilities and to provide serviceable components to the theater of operations. This will require that adequate terminal facilities and techniques be provided to efficiently process reparables into the air transportation system.

b. Recommendation

(MT-17) Each Service develop and refine reparable control systems for selected components which will:

(a) Ensure that, from the time of removal from a major end item, the location and status of each component is known at the proper management levels until it is repaired and returned to service or condemned and dropped for disposal.

(b) Make appropriate use of air transportation for movement of reparables.

APPENDIX A

A CASE STUDY ON THE GUIDANCE AND CONTROL SYSTEM OF THE MINUTEMAN MISSILE

1. BACKGROUND

a. As the complexity of technology increases, the acquisition cost of weapon systems increases and the follow-on operational and maintenance costs tend to increase accordingly. The maintaining of maximum operational readiness is of utmost importance to the Department of Defense while recognizing the need for reducing total logistics costs. The purpose of this paper is to examine the Integrated Materiel Management concept utilized by the Air Force in supporting the guidance and control package of the MINUTEMAN missile. Similar concepts exist in other Services but were not reviewed.

b. The Strategic Air Command (SAC) has been assigned responsibility for the operation of these missiles. The Air Force Logistics Command provides logistic support to SAC and other major commands. Its primary agent for MINUTEMAN is the Ogden Air Materiel Area which is designated as the system manager.

c. The Air Force Logistics Command uses a contract operated airlift known as LOGAIR, which serves major Air Force Bases in CONUS daily including missile support bases. Shipment of the MINUTEMAN guidance and control package to the depot has taken advantage of this existing transportation system.

2. DEPLOYMENT OF MINUTEMAN MISSILES

a. MINUTEMAN missiles are strategically deployed in the northern section of the continental United States. Each missile is not less than 5 miles, and an average of 8 miles, from the next missile in its location in a hardened underground launch tube.

b. The MINUTEMAN launch facilities are located as far as 150 miles from the strategic missile support base which is the source for maintenance personnel, repair equipment, and spares units for replacement of failed items.

c. Guidance and control assemblies installed on these missiles, within the launch facilities, must operate 24 hours a day, seven days a week.[1] Thus, the guidance and control assemblies must have a high mean-time-between-failure or a high replacement demand can be anticipated. The guidance and control assembly costs approximately $198,000 for MINUTEMAN I (NS-10), approximately $428,000 for MINUTEMAN II (NS-17), and $510,000 for MINUTEMAN III (NS-20). Not only is this the most expensive component on MINUTEMAN, but it is also the most complicated. The NS-10 is comprised of over 7000 electronic and mechanical parts, the NS-17, 15,000 and the NS-20, 17,000.[2]

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[1] Richard G. Miller, Maintenance/Van Loading, Scientific paper published in Society of Logistics Engineer, June 1968, Odgen Air Materiel Area, Air Force Logistics Command.

[2] Ogden Air Materiel Area, Briefing, subject: LGM-30 Integrated Materiel Management, 7 February 1969.

3. MONETARY INVESTMENT

a. In view of the high cost of the guidance systems, the determination was made to procure the absolute minimum number of spares based upon reliability projections. It followed that every segment of the logistic process would have to be optimized.

b. The significant initial investment in hardware coupled with the operational and maintenance expenditure each year gave credence to the selection of these items for intensified management. The investment by the Air Force for guidance and control systems and missiles is shown:

	Inventory		Cost ($ millions)		
MINUTEMAN	Opl.	Spares	Spares	Test Equip.	Total
I	935	131	211.1	90.0	301.1
II	647	108	323.1	78.9	402.0
III	514	94	310.1	107.8	417.9

Initial investment in test equipment covers equipment required at Newark Air Force Station, Ohio, to perform the depot maintenance repair on the guidance and control system.[3]

4. HIGH VALUE LOGISTICS MANAGEMENT

a. The normal high value management of the NS-10 MINUTEMAN I guidance and control system would have provided for the following:

(1) A base stock level of 15 days

(2) A depot stock level of 15 days

(3) A repair cycle consisting of 45 days floating stock.

b. The quantity and cost of the NS-10 guidance system if normal levels would have been procured is shown:

Level	Days	Guidance & Control Systems	Cost ($ millions)
Base Stock Level	15	68	13.5
Depot Stock Level	15	68	13.5
Repair Cycle Level	45	204	40.4
Total		340	67.4

c. The only spares actually procured were those required to fill the repair cycle pipeline. This pipeline consisted of the following segments: removal and return to base, shipment to the overhaul facility, repair time and transportation time to return the repaired assembly. Obviously the repair cycle itself would have to be minimized. Plans were made for moving the guidance and control assemblies by the most expeditious means, basically by air, for multishift operations by the repair facility and for personalized monitorship of each guidance assembly by serial number.

[3] Ibid.

d. Computation of the repair cycle spares was made by using the following formula:

$$\frac{\text{Qty Failing per Month} \times \text{Repair Days}}{30 \text{ Days}} = \text{Floating Stock}$$

e. Computation under the normal 45-day repair cycle would have required the following spares:

$$\frac{136 \times 45}{30} = 204$$

f. Actual computation used for the procurement of the NS-10 system resulted in the following spares:

$$\frac{136 \times 29}{30} = 131$$

g. The cost avoidance realized as a result of the elimination of the base and depot stock levels and a reduction of the 45-day repair cycle to 29 amounted to $41,500,000.

h. For each day the repair cycle can be reduced, 4 units need not be procured.[4]

Item	Units	Unit Cost ($)	Cost Avoidance ($)
NS-10	4	198,000	792,000
NS-17	4	428,000	1,712,000
NS-20	4	510,000	2,040,000

5. GUIDANCE SYSTEM RELIABILITY

a. The planned reliability of the NS-10 guidance and control system was predicted by the design engineers to start at a low mean time between failure at first installation (Oct 62) at Wing I and increase to peak mean time between failure in July 65 after completion of installation at Wing V. The guidance and control system was produced in three different models, NS-10Q1, NS10Q2 and NS-10Q3. As newer guidance and control models were introduced into the MINUTEMAN system, modifications were incorporated in order to increase operational capability.

b. The actual mean time between failure was slightly higher than expected through the early life. In January 1964 a significant improvement (of more than 500 hours) was experienced when the third model of the guidance and control system was introduced. The mean time between failure remained essentially constant from July 1965 through December 1966 but subsequently has continued to improve.

c. The planned reliability of the NS-17 guidance and control system was predicted by design engineers based upon the performance experienced with the NS-10. The NS-17 guidance and control systems that were installed at Wing VI performed at approximately one sixth of the predicted mean time between failure. Major changes in the state-of-the-art of electronics engineering were developed at the time the NS-17 was being designed and micro-miniature electronics modules replaced the miniature electronic modules that were used in the NS-10. In addition major changes in the inertial instrument were incorporated. These major changes without an adequate reliability program to ensure attainment of the mean-time-between-failure goal

[4] Ibid.

resulted in the reduced mean time between failure. The reliability program had been reduced drastically based on the assumption that the NS-10 reliability experience could be utilized on the NS-17.[5]

d. Because the NS-17's were failing at a rate of six times higher than expected in early 1967, it was determined that an all-out effort had to be made to improve the reliability of guidance systems and increase the repair capacity for the guidance and control system. Because of the thousands of electronic parts in the NS-17, it was determined that retrofit of the more than 400 systems produced would be too costly. Major reliability changes would be incorporated into the slightly more than 300 systems to be produced. Logistic support must be changed to meet the mix of the total population and the resultant mean time between failure. Logistic support at this time was extremely critical. Production requirements in conjunction with repair requirements had saturated and backlogged the contractor. The contractor's repair time was more than twice the planned contract repair time and nearly three times the turnaround time planned at the Air Force Logistics Command repair activity, Newark Air Force Station. The decision was made to staff the Specialized Repair Activity at Newark Air Force Station with the necessary equipment to repair the total monthly repair requirement of NS-17's. Tooling was removed from the contractor plant beginning in April 1967 and was completed in August 1967. This transfer of equipment increased the repair capacity without additional major equipment procurements and reduced the requirement for procurement of additional pipeline spares by taking advantage of a shorter turnaround time.[6]

6. REPAIR REQUIREMENTS

The repair requirements shown are separated into projected failures per month, failures per year, costs of repair per single guidance and control system, and total cost of repair per year. The cost per repair is the cost which is used in the depot maintenance industrial funding and accounting program.[7]

Repair Reqmts	Failures Per Month	Failures Per Year	Cost Per Repair ($)	Cost Per Year ($)
MINUTEMAN I NS-10	136	1632	10,000	16,320,000
MINUTEMAN II NS-17	148	1776	10,000	17,760,000
MINUTEMAN III NS-20	116	1392	12,000	16,704,000

7. REPAIR CYCLE PLANNING AND CONTROL

a. The repair cycle for the NS-10 and NS-17 guidance and control systems is composed of six individual logistics segments. The specialized repair activity is an Air Force depot repair facility which has been staffed with skilled personnel and test equipment to repair recoverable assemblies.

b. Field failures in the MINUTEMAN guidance and control system are identified by continuous monitoring equipment designed into the weapon system. The launch control officer is, therefore, immediately knowledgeable of a failure and he informs the job control center at the missile launch facility. A maintenance crew, available on a 24-hour basis is then dispatched in a special guidance system van with a serviceable guidance system and other necessary equipment required to accomplish the task of confirming the failure and replacing the guidance system.

[5]Ibid.
[6]Lloyd Norseth, Procurement of Spare NS-17 Guidance and Control Systems, Fact sheet prepared for Mahon Committee, Ogden Air Materiel Area, Air Force Logistics Command, July 1969.
[7]Ogden Air Materiel Area, Briefing, subject: LGM-30 Integrated Materiel Management, 7 February 1969.

c. Special streamlined handling procedures have been designed to reduce the repair cycle time. A time line of 5 days has been established for an average guidance system replacement.

d. The Strategic Air Command maintains a continuous job training program at each wing to ensure that the programmed maintenance times are met.[8]

8. MAINTENANCE CONCEPT

a. The MINUTEMAN maintenance concept is divided into three levels of maintenance: organizational, intermediate, and depot. Organizational maintenance is accomplished at the launch facility and is essentially a remove and replace operation. A voice reporting system, a prerecorded tape system that is part of the operational ground equipment, advises the launch control officer of the conditions of failure in the launcher. Organizational maintenance teams, using portable test equipment, are dispatched from a centrally located strategic missile support base to isolate and verify the fault to a guidance system and to replace the faulty system.

b. The failed guidance and control system, removed by organizational maintenance personnel, is returned to the strategic missile support base where intermediate maintenance personnel prepare the guidance system for shipment to the depot. There is no strategic missile support base repair capability for the guidance and control system.[9]

9. MAINTENANCE VAN LOADING

a. In view of the wide dispersion that exists between launch facilities in the MINUTEMAN missile and the great distance from the strategic missile support base, a maintenance technique to ensure availability of support elements was required. Compounding the problems was the fact that many failures were occurring monthly in each wing. These failures were random in nature; therefore, several could occur in one day while many days could elapse with very few failures.

b. A system, called maintenance van loading, was developed to determine what could be the most cost effective maintenance technique. Maintenance van loading is a management technique used to determine the correct number of support elements, in this case guidance systems, as well as portable test equipment and maintenance vehicles that are required for dispatch to an unmanned ballistics missile launch facility to assure the user of the maximum number of in-commission launch facilities at a minimum logistics cost. A special problem exists within the MINUTEMAN system as launch facilities are widely dispersed and all organizational maintenance is dispatched from the strategic missile support base. Launchers and their operating ground equipment cannot be brought to the support base but must remain an average distance of 100 miles away. Average driving time one way is approximately 2.8 hours. Dispatched maintenance teams must, therefore, carry on each trip all the support elements required to correct the failure identified only as a major subsystem by monitoring equipment. Consequently "mathematical models" and "van loading tables" were developed showing which hardware failure possibilities were most likely to have occurred to ensure that only those small quantities are taken on the first trip to the launch site. This technique provides replacement coverage for the majority of the total possibilities of hardware failure. Experience has caused a refinement of these tables to the point where second trips are most unusual. A savings estimated in the initial effort of $13,000,000 has been realized through the use of the method.[10]

10. NOT OPERATIONALLY READY—SUPPLY (NORS) RATES

a. The average NORS rate for MINUTEMAN I and MINUTEMAN II, for other than the guidance and control system, has been less than 1 percent. The NS-10 guidance and control system did experience NORS rates of 0.01 to 5.8 during the learning period curve for repair activity

[8] Ibid.
[9] Ibid.
[10] Richard G. Miller, Maintenance/Van loading, Scientific paper published in Society of Logistics Engineering, June 1968, Ogden Air Materiel Area, Air Force Logistics Command.

and during the period when field installation of the missiles in their launching facilities was increasing. From October 62 to December 65, 626 NORS events occurred. The average time for each of the NORS events was ten hours. The out-of-commission time for guidance and control was 0.28 percent. This was below the theoretically predicated computation of 0.5 percent. The achievement of a NORS rate lower than predicted was due to the absolute control of the guidance and control assets, flexibility and responsiveness of the specialized repair activity, and finite planning and control of each segment of the repair cycle.[11]

b. Monthly predicted failures for the NS-17 guidance and control system equated to 18 failures per wing per month. This prediction was based upon projection reliability factors. Initial failures experienced were more than six times the failures predicted per month. At this time the guidance and control NORS rate rose to more than 14 percent. A recovery team was established to study all facets of the problem such as reliability, repair capability, and field support. One of the results of the study indicated that the NS-17 required a number of changes to achieve increased reliability. The contractor was directed to submit engineering change proposals which could be programmed into the NS-17 production. The retrofitting of NS-17's produced prior to the engineering change proposals was considered. An analysis indicated that retrofit was neither practical nor cost effective owing to the complexity of the system. This resulted in the decision to procure 108 spares although the spares requirement to support the mean time between failure would have required a spares buy of 122. The decision to reduce the buy from 122 to 108 was a System Manager decision based on the fact the MINUTEMAN II force size, after peaking at 500, would immediately begin to reduce as a result of the planned operational test firing rate. In addition, the decision was made to expedite the move of the repair tooling from the contractor to the organic facility at Newark Air Force Station, Ohio. Utilizing the organic repair capability, controlling the systems in the repair cycle, and reducing the turnaround times in a 9-month period reduced the NORS rate for the NS-17 guidance and control system to zero where it has remained since the latter part of 1967.[12]

11. SPECIALIZED REPAIR ACTIVITY

a. The specialized repair activity segment is the longest, most complex, and costliest of the entire repair cycle. For these reasons considerable preplanning action must be accomplished during the design and acquisition phase. Because of the tremendous investment involved in the specialized repair activity the Rand Corporation was asked to conduct a simulation study which would give the best equipment layout with the least possible time for total repair.

b. Automated test equipment was designed and installed wherever possible within the specialized repair activity. Automated equipment allows for more rapid trouble shooting and fault isolation. Much of the manual probing, which is normal within the electronics repair business, has been eliminated. The use of automated test equipment must be determined during the design phase in order that adequate test points can be developed in the system hardware.[13]

c. The specialized repair activity operates under the parallel line concept. Under this concept the guidance system and each of its major subassemblies is assigned its own test equipment, manpower, etc. Each is assigned its own time lines using standard industrial engineering techniques as a basis for that time. A floating stock computation provides an adequate quantity of components to support the line. The parallel line repair method provides the fastest possible time processing for the guidance systems at the least investment cost.

d. Floating stock requirements for each subassembly are computed using the following formula:

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[11] Directorate of Materiel Management, Liaison visits, NORS Rate, Ogden Air Materiel Area, 22 September and 12 November 1969.

[12] Lloyd Norseth, Procurement of Spare NS-17 Guidance and Control Systems, Fact sheet prepared for Mahon Committee, Ogden Air Materiel Area, Air Force Logistics Command, July 1969.

[13] Ogden Air Materiel Area, Briefing, subject: LGM-30 Integrated Materiel Management, 7 February 1969.

$$\frac{\text{Qty per Month} \quad \text{Repair Days} \quad \text{Repair Frequency}}{\text{30 Days}} = \text{Floating Stock}$$

Qty per month = failure rate of Guidance and Control Systems

Repair days = numbers of days to repair subassembly

Repair frequency = percentage ratio of subassembly failure to system level failure.

e. The detailed turnaround time repair actions for the NS-10 & NS-17 Guidance and Control Systems are shown as an example. Each of the major subassembly lines have been planned on the same basis.[14]

NS-10

Function	Days
Stage in	0.71
Rec. and insp.	0.38
Malfunction and verification	1.72
Cut and weld	0.53
Diagnostic	3.78
Remove and replace	4.44
Repair verification	1.76
Previbration	1.93
Vibration	0.53
Postvibration	1.41
Cut and weld	0.81
Final functions	1.51
Stage out	0.52
Total days	20.03

NS-17

Function	Days
Stage in	1.41
Rec. and insp.	0.65
Malfunction and Verification	2.80
Remove and replace gyro	0.48
Remove and replace computer	0.32
Remove and replace guid. control	0.32
Remove and replace amplifier	0.32
Remove and replace body section	0.18
Minor repair	0.48
Final function test	4.17
Stage out	1.41
Total days	12.54

The difference in design concept and construction allows the NS-17 to be repaired in fewer repair days. The NS-10 is a single package pressurized as a total unit. The NS-17 is composed of four pressurized units and therefore lends itself more easily to the remove and replace concept of repair.

f. In actual operation the time line of each function must be continually checked to ensure that it is being achieved or that action is taken to correct deficiences.

[14] Ibid.

g. The specialized repair activity must perform the following functions if it is to remain on schedule:

(1) Predict input/output requirements each month.

(2) Track turnaround time against engineering standards.

(3) Analyze production delays.

(4) Take action to resolve delays.

(5) Provide contractual assistance.

(6) Provide technical changes

h. It has been found that in the integrated materiel management system each function must be more closely monitored than ever before. The elimination of base and depot stock levels has eliminated the reparable asset cushion upon which a specialized repair activity normally depends for workload stabilization. The elimination of these levels plus the fact that there is no planned maintenance cycle for the guidance system dictates that the specialized repair activity must depend upon failure generation and creates the necessity for new techniques of workloading to manage the specialized repair activity. Actuarial, regression analysis, mean-time-between-failure tracking, and predicting of field modification effects are techniques in use to predict the specialized repair activity workload.

i. Failure rates for each component, module, subassembly and system were first developed during the initial design phase. Successful repair cycle operation is, therefore, dependent on constant knowledge of any change to these rates. During the operational phase the achieved failure rates must be constantly compared with the planned rates in order to predict changes in behavioral patterns and to adjust procurement actions within lead times.

j. Performance data of a system prior to repair and after repair are closely compared. This comparison is used to be certain that maintenance functions, or actions, are not degrading the mean time between failure or mission performance. By comparison of these data any performance degradation would be detected and changes would be made to the maintenance function as required.[15]

k. Failures in the guidance and control system of the MINUTEMAN missiles have always occurred at random. Therefore, planning for depot repair on a routine cyclic basis has not been possible. Monthly failures have varied from a low of 91 to a high of 136. In view of this occurrence the specialized repair activity must be flexible and sufficiently responsive to react to this condition immediately to prevent a degradation in operational readiness. Since the depot repair capability is organic to the Air Force Logistics Command and supports the Ogden Air Materiel Area, responsiveness to the fluctuating guidance and control repair requirements can be immediate. Flexibility in depot maintenance operations has been maintained by being able to reduce or increase the work shifts as required, using overtime where necessary, and utilizing cross-trained personnel from other weapon system repair lines to supplement the normal work force. As a result of this effort the guidance system NORS rate has been at zero since 1967.

12. GUIDANCE AND CONTROL SYSTEM SPARES COST AVOIDANCE

a. The following indicates the MINUTEMAN guidance system cost avoidance which will be completely realized when the final guidance procurement is completed.

[15] Ogden Air Materiel Area, Briefing, subject: LGM-30 Integrated Materiel Management, 7 February 1969.

	Standard Acquisition		Intensified Acquisition	
	Units	Cost ($)	Units	Cost ($)
NS-10	340	67,300,000	131	25,900,000
NS-17	374	160,100,000	108	46,200,000
Total		227,400,000		72,100,000

Cost Avoidance $155,300,000

b. The standard acquisition segment above is based on the procurement of a 15-day base stock level, a 15-day depot stock level and a 45-day repair cycle level. Had each of these levels been stocked on each guidance system, the quantity of units at the dollar cost indicated would have been procured.

c. The intensified acquisition segment is based on the elimination of the base and depot stock levls and the reduction of the repair cycle to twenty-nine days for the NS-10 system, and twenty and a half days for the NS-17.

d. Some risk is involved when the integrated materiel management concept is implemented, primarily because of the elimination of base and depot stock levels. Planning errors or changed hardware failure factors not immediately detected can cause degradation in logistic support. NORS occurrences can be expected and the magnitude and time of these impacts will be proportional to the accuracy of the planning factor.

e. The planning actions that should be taken to reduce the risk of degraded support are as follows:

(1) A major component should have a planned built-in reliability program to ensure the achievement of the design mean time between failure.

(2) Track the actual mean time between failure as production begins and throughout the operational phase to ensure the ability to respond rapidly to adjust the initial logistics elements as required.

(3) Advance production of major end items and subassemblies early in the program will provide a cushion stock to absorb some of the planning errors of hardware problems which ordinarily occur early in the life of a major assembly.

(4) Assured provisioning of adequate quantities of the lowest indentures of bits and pieces is cost effective. Transistors, resistors, diodes, etc., are very inexpensive in relation to the investment costs previously exhibited for an additional day's repair time if an out-of-stock condition exists.[16]

13. SUMMARY. The Integrated Materiel Management Concept, used by the Air Force in supporting the guidance and control system of the MINUTEMAN missile, brought out two significant factors.

a. The intensified management of high cost assemblies permitted the minimizing of investment costs.

b. Optimistic projection of reliability can create logistic problems when used as a basis for procurement of support requirement.

[16] Ibid.

GLOSSARY OF TERMS

Cost avoidance—avoiding the expenditure of investment dollars in the spares area without major impact on the operation of the weapon systems.

Flights—ten MINUTEMAN missiles located in their launch facilities electrically connected by underground cable to a manned launch control facility.

Mean time between failure—a reliability expression in hours wherein the total operating hours is divided by the total number of failures.

Regression analysis—mathematical method of determining a curvilinear line through the midpoint of a set of data.

Repair cycle—the amount of time expressed in days from failure of a guidance system in a launch facility through the removal process, transportation, repair at a specialized repair activity, transportation and receipt of the serviceable guidance system at a MINUTEMAN base.

Time line—the industrial engineering standard time required to accomplish a specific job or action.

Floating stock—stock of components at the depot maintenance level used to effect minimum repair flow time of the primary end item.

APPENDIX B
REPAIR LEVEL DECISION MODELS

1. INTRODUCTION

a. The making of a repair level decision involves the identification of all maintenance tasks, determining a capability for performing the task, aligning these to the Service mission, and arriving at the best balanced maintenance plan capable of performing the tasks in terms of time, tools, test, and support equipment skills and employment of the item.

b. The primary use of models for actions related to repair level decisions is to accomplish trade-offs in support concepts to ensure the best balance between operational and support effectiveness over a life cycle period which will minimize total system cost. Through models the elements of significant impact—environment, personnel, facilities, test equipment, and supply support—have the potential of being placed in perspective to define their influence.

c. The following paragraphs describe logistic models being used by the Services in selected application allied to the repair level decision.

2. LEVEL OF REPAIR DECISION

"The level-of-repair (LOR) decision for an item of Naval Aviation equipment has extensive consequences. Costs incurred for parts, inventory management, training, and many other support elements must be budgeted. Priceless space aboard carriers must be allocated to support equipment, work space, storage of parts and manuals, and technician quarters. The Navy has decided that repair decisions based on judgment alone can result in excessive costs and can drain off valuable resources needed to maintain Naval Aviation effectiveness.

"This report provides the Navy with a rational basis for making LOR decisions. Navy or contractor decision-makers can apply the procedures shown below:

- Consider all alternatives in the repair spectrum—including:
  - Discard
  - Intermediate Repair
    - Shipboard
    - Shore based
  - Depot Repair
- Display the cost consequences for various alternatives
- Assure that each alternative will provide an equal level of Naval Aviation effectiveness
- Allow for overriding noneconomic considerations
- Identify the least costly alternative as the selected LOR decision.

"This procedure is illustrated in the chart on the following page.

Level of Repair Decision Process

"The procedure described in this report is not entirely new. General Dynamics has drawn on its own extensive experience in LOR decision making. We have added the best contributions of the many students of this subject who have been considering repair level and discard questions for more than a decade. Key features of the methodology are:

- Prepare and use graphic screening aids (decision charts) to obtain most decisions quickly and easily.
- Conduct detailed total cost analysis to:
  - •• Resolve questionable decisions,
  - •• Support management review of non-economic decisions, and
  - •• Provide inputs to other Navy models.

Key Features of LOR Decision Methodology

"Along with the methodology summarized above, General Dynamics presents in this interim report

- A thorough, critical review of the evolution and status of LOR decision technology
- Recommendations for continuing progress in LOR decision methodology.

"Our conclusion is that valid LOR decision analysis is feasible. The review of LOR decision technology pointed out that Logistics Management Institute and RCA have both developed practical methods of LOR application. These and other reviews are described in this report. At this time, we believe that LOR analysis is an economic necessity if the costs of adequate support are to be kept within reasonable limits. We therefore recommend that the Navy

- Assign qualified personnel charged to assure implementation of LOR procedures
- Refine and improve the methodology as experience accumulates and
- Exploit a potential breakthrough in the application of computer technology to LOR decision analysis

"In the final report, to be published subsequently, the validity of the procedures will be demonstrated. Actual avionics items of the F-4B weapon system will be examined from two points of view:

- LOR decisions appropriate to the remaining equipment program life will be derived
- LOR decisions as they might have been made during the conception of the F-4 program will be reconstructed.

"The final, validated methodology will provide for the Navy a logical means for making the optimum selection among various alternative discard and repair-level choices. The Navy will be assured that the selection thus made will support a selected acceptable level of Naval Aviation effectiveness."[1]

3. LOGISTICS COMPOSITE MODEL (L-COM)

"L-COM is a computer procedure for simulating overall operations and support functions at an Air Force base. It was developed by AFLC and RAND personnel as a simulation model for the PACER SORT project. The objective was to determine the best mix of base and depot level repair, with associated requirements for maintenance personnel, ground support equipment, repair parts, transportation, communications, and other supporting resources.

"The model consists of three main programs: (1) a preprocessor for generating sortie requirements according to a specified flying program, (2) a simulation program for representing flight and base support processes in response to mission requirements, and (3) a postprocessor for providing results in a form convenient for analysis.

"The logic of the simulation model replicates

- flying of aircraft
- accomplishing of service tasks (e.g., refueling and weapons loading)
- incurrence of malfunctions
- accomplishment of flight-line aircraft maintenance
- repair of components in base repair shops
- utilization and interaction of resources in the demand process
- changes in resource availability according to shift policies
- other facets of overall base operation.

"The simulation may include

- multiple aircraft types
- several dozen types of maintenance personnel
- approximately a hundred different types of AGE
- several hundred kinds of spare parts

"Resource mix and total resources included are constrained only by computer capacity. While a simulation is in progress, the user may apply embedded decision routines. These routines determine whether specified performance goals are being met and if not, they selectively augment resource levels until the desired performance objectives are being attained. The choice of which resource to augment is made by identifying the resource which will provide the greatest increase in effectiveness per dollar required for an additional item. Thus AGE, personnel, spares, etc., are all eligible for augmentation.

[1]General Dynamics, Level of Repair Decision Rules, Fort Worth Liaison, Interim Report FXM-12-10586, 27 March 1969.

"The main model output is a performance summary report produced at specified intervals during the simulation. This report presents summary statistics in six functional categories: operations, aircraft, personnel, shop repair, supply, and equipment.

"L-COM is to be validated by comparing simulation results to project PACER SORT operational data. Validation results have not been published. The AFLC Optimum Life Cycle Logistics Cost Model I (RGM I) has not yet been used to provide the LOR and accompanying task network input data. Since L-COM is still being validated, the necessary logistic support data have been determined from records of F-4C project PACER SORT field operations.

"Comments: L-COM is a completely integrated procedure for in depth analysis of support systems. The model is uniquely structured for such studies, since different kinds of repair processes can be represented by input data only, rather than by changes in the computer program. This step is accomplished by including in the input the task network that describes base processes by identifying particular tasks and the sequence for accomplishing them. Input data prescribe durations and resource requirements for each task. By providing network and related data, the user exercises direct control over the simulated environment. Thus, L-COM can analyze any postulated repair policy with corresponding variations in the repair processes involved."[2]

4. PRELIMINARY REPAIR LEVEL ANALYSIS MODEL (PRAM)

"PRAM was developed to examine cost trade-offs between Aerospace Ground Equipment (AGE) and recoverable end items. It is a simple computerized model which provides a relatively straightforward method for organizing relevant cost and item data into sets of cost aggregates and item levels for convenient comparison and analysis. The elements pertinent to the LOR decision are separated into benefits and costs associated with addition of an AGE unit at a base location.

"Benefits obtained by adding AGE

1. Added Flexibility—repairs can be made at base or depot.

2. Greater Responsiveness—base maintenance may be expedited or deferred; depot repair might be cut off or restricted tactically.

3. Reduced Recoverable Item Inventories—initial investment cost and recurring transportation and holding costs are reduced.

4. Other Savings—airlift requirements for resupply purposes as well as packing, crating, handling and loss in shipment may be reduced.

"Costs incurred due to addition of AFE

1. AGE Costs—investment cost tempered by joint cost-allocations and amortization schedules.

2. Personnel Costs—more personnel with higher skill levels are required. Additional personnel overhead is also incurred.

3. Facilities Costs—shelter, power, and environmental control are frequently required.

[2] Rand Corporation, Memorandum RM-5544-PR, The Logistics Composite Model: An Overall View, May 1968.

4. Spares Support—spare parts to support both the repair operation and the AGE become necessary.

5. Technical Data Requirements—instructions for performing repairs require investment expenditures and add to deployment cost and weight.

6. Transportation Costs—principal AGE transportation cost is incurred upon deployment.

7. Other Considerations—security, facilities, vulnerability, etc.

"To get a rapid appraisal of the relative merits of having the end-item repair performed at base level or at depot level, the analyst must obtain detailed data describing the repairable item and all associated support cost factors. It is recognized that much of the data will consist of gross estimates, especially during the design phase.

"For each of the two conditions—no AGE available at base level (i.e., all end-item repair is performed at the depot) and AGE available at base level—the following outputs are calculated:

- End item stock level (this number may be computed to yield a specified effectiveness or to conform to present Air Force stockage policies)
- Total stock cost
- Yearly operating costs
- Five-year operating cost
- Five-year total cost.

"Comments: PRAM is a useful procedure for studying the effects of various factors on the repair-level decision. The sensitivity of cost to demand rate and Not Reparable This Station (NRTS) rates as well as the interaction between demand rate and the end-item/AGE cost ratios have been examined in parametric analyses. One significant conclusion from these analysis is that "if only economic considerations were taken into account it would be wrong to have a general rule of thumb to the effect that cheap items should be repaired at base and expensive items sent back to the depot."[3]

5. OPTIMUM LIFE CYCLE LOGISTICS COST MODEL I (RGMI)

"The information summarized here was obtained from drafts and manuscripts.

"The 'Notes' describe a procedure for determining a logistic support policy that will minimize expected cost of logistic support activity during the lifetime of the weapon. The problem is formulated in terms of set theory and solved by application of a dynamic programming algorithm.

"The process of interest is the failure of a weapon system component and its subsequent repair. The process evolves through a sequence of states. Each state is identified by item location (flight line, shop, or depot), indenture level, and the level of fault isolation. Transitions from one state to another are dictated by a

[3]General Dynamics, Level of Repair Decision Rules, Fort Worth Division Interim Report, FZM-12-10586, 27 March 1969.

decision policy. For example, the possible decisions regarding a faulty second indenture assembly located in the base shop are

1. Diagnose (isolate fault to the next lower indenture level),
2. Transport the assembly to the depot for repair,
3. Remove and replace a particular faulty component, and
4. Discard the entire unit.

"By evaluating the cost consequences of every possible decision at each possible state, the model identifies the set of decisions which minimizes expected logistic support costs for the weapon system lifetime. This set of decisions constitutes the optimum logistic support policy. The evaluation begins with the lowest indentures and employs a series of nested subroutines to 'build' a decision policy all the way to the weapon system itself. Program outputs include requirements for maintenance personnel, supply levels, and AGE items corresponding to the least-cost repair level decisions. The most important outputs, however, are the decisions themselves and the network of specific tasks required to support the weapon system. The selected logistic support policy (repair-level decisions, task network, and support resource requirements) provide critical inputs to the AFLC-RAND Logistics Composite Model (L-COM).

"The SIMSCRIPT computer program, RGM 1, is a comprehensive, well-conceived repair-level decision model that can consider an entire weapon system through five indenture levels. The computer program and sample data are available to interested parties. The following aspects bear most directly on the state of LOR technology:

A. The costs of alternative decisions at any state are determined according to specifications set forth in AFLCM/AFSCM 375-6. Approaches regarding AGE and spares are of particular interest.

   (1) AGE cost is not allocated to particular aircraft components in proportion to the percentage of AGE workload the respective components generate. Instead, the computation proceeds in each case on a "no AGE" basis and again on a "with AGE" basis. Output report formats allow the analyst to compare the total costs for both concepts. At the higher indenture levels, AGE costs (for alternative decisions) are summed over several items and then compared, so that the problem of allocating a particular AGE item cost to a particular reparable item ceases to exist.

   (2) Quantities of spare required to support the aircraft are initially computed by a linear approximation and later refined according to regulations specified in AFM 67-1. Further refinement may be obtained by applying some optimal stockage policy external to RGM 1.

B. Results of model test runs have been consistent with actual operations studied in Project PACER SORT. When proper constraints are applied, the model will select present-day repair policies. Test data have included the F-4C Autopilot and Fire Control Systems and selected Light Intratheatre Transport (LIT) data.

C. A major advance is the relating of logistics support costs to the end items that require them. The procedure considers the interrelationship of the LOR decision for one part with those for others; this recognition is consistent throughout the range of indentures.

D. The scope of equipment being considered may be as broad as an entire weapon system or as narrow as a single LRU, its subassemblies, modules, etc. For a large problem, data collection presents a significant task, but the data requirements are no greater than for other logistics models or, for that matter, for the normal provisioning process.

E. Certain aspects of the operational environment are not represented in the model logic (e.g., use of substitute items, cannibalization, task preemption). Probably the most important of these omissions is a dynamic flying program. Since the main cost elements can be closely determined without such refinements, these complicating and analytically difficult aspects were not incorporated. The model was conceived as a modular component of the L-COM model. Its outputs are designed as input to the L-COM simulation which includes the environmental features. Effectively, then, L-COM can be used to evaluate the decisions identified by RGM 1.

F. RGM 1, unlike most other level-of-repair models, provides total cost outputs (as opposed to incremental or cost-difference outputs).

"Comments: This model and its computer program are exceptionally ingenious. The procedure is a distinct advance in the state of LOR technology. At this time it appears likely that the model logic can be adapted to represent Navy activities. Various cost factors in the computer program could readily be replaced by corresponding Navy factors. These facts indicate that a computer procedure compatible with the VALUE and SCORE models could become available relatively soon."[4,5]

6. SUMMARY. The Services and Industry are pursuing the development of techniques for making the repair level decision. Models, using computers and aligned to logistics, have been used in specific cases for quantifying the impact of the repair level decision on logistic resources. Currently, there is no general application of models to the repair level decision process within the Services.

[4]U.S. Air Force Logistics Command, RGM-1 Executive Summary, Operation Analysis Report No. 9, June 1969.
[5]Department of the Air Force, Optimum Repair Level Analysis, Panel 31 Joint AFLC/AFSC Task Group on Program Management Working Relations, June 1966.

APPENDIX C
TECHNICAL DATA

1. GENERAL

a. As weapons become more complex, the requirement for supporting data increases rapidly. The Department of Defense annual expenditures of $2 billion for technical data requires close continuous management of the programs for acquisition, use, and maintenance of these data.

b. Technical data are recorded information used to define a design and to produce, support, maintain, or operate items of defense material. These data may be recorded as graphic or pictorial delineations in media such as drawings or photographs; text in specifications or related performance or design type documents; in machine forms such as punched cards, magnetic tape, computer memory print-outs; or may be retained in computer memory. Examples of recorded information include engineering drawings and associated lists, specifications, standards, process sheets, manuals, technical reports, catalog item identifications, and related information.

c. The subject of technical data and publications has been a major issue within the Department of Defense for a decade. Early Office of the Secretary of Defense efforts to foster economy and ease of management were accomplished by guidance to the Services which encouraged them to standardize internally. As the Services' internal systems have evolved, Office of the Secretary of Defense policy has become more directive in nature, with management progressively centralized. The earlier latitude granted the Services in the areas of interpretation of intent, delineation of responsibility, and requirements for coordination has been narrowed as respective policies have been developed and the resulting disparities identified. Current policy represents an even more centralized concept and is in the process of being implemented within the Services.

d. The impetus of the Office of the Secretary of Defense efforts in the data area has been directed toward the elements of requirements determination, data acquisition, and visibility with respect to that data being acquired for the support of new systems. Some effort has been expended in standardizing data specifications but no Office of the Secretary of Defense program is under development to improve data usability, accuracy, or timeliness for maintenance personnel.

e. Over the past 10 years the volume of technical data required by all levels of maintenance activities has grown to such proportions that it is extremely difficult to provide the initial and updated data in paper form in a timely manner. The Army library includes approximately 18,000 technical manuals. At the present time there are about 29,000 aeronautical and 60,000 Navy ships technical manuals (does not include technical directives) which are handled in the Navy/Marine Corps maintenance activities. The Air Force Technical Order System is composed of about 76,000 different technical orders. The Marine Corps uses approximately 1,500 technical manuals and technician instructions for support of equipment other than aircraft. This quantity presents serious difficulties in the storage, data integrity, technical accuracy, data retrieval, and the time and cost to update and distribute the necessary data. Despite substantial improvements in printing techniques, there still remain major problems. The lengthy time required to reproduce, update, and distribute technical data hampers, to a great extent, the probability of delivery of the initial or changes data concurrent with the delivery of the new "Hardware" item or equipment modified to another configuration.

2. DESCRIPTION

a. Office of the Secretary of Defense

(1) The Assistant Secretary of Defense (Installations and Logistics) exercises overall management control of the Department of Defense Technical Data Management Program and the Director of Defense Research and Engineering exercises overall management control of the Department of Defense Scientific and Technical Information Program. In carrying out this responsibility, the Assistant Secretary of Defense (Installations and Logistics) provides for the development and maintenance of a Department of Defense Technical Data Management Manual.[1]

b. Army

(1) Responsibility for determination of data requirements and preparation of necessary technical publications is vested in the commodity command/project manager responsible for system development. The scope of data collection and the types of publications required are determined based on the concept of employment and support of the system. The keystone to this effort is the concept of maintenance support envisioned which determines the level at which repairs are to be made and in turn dictates the technical information required at the various levels of maintenance. The preparation of technical manuals is performed organically or by contract with the final source determined on a cost/availability analysis by the responsible manager. Data requirements included in hardware contracts are covered by applicable quality assurance specifications and standards to ensure uniformity of format and style, and adequacy and accuracy of technical content.

(2) Distribution of technical manuals within the Army is made by The Adjutant General based on requirements established by using activities. Initial issue to newly activated units is made automatically, based on a review of equipment and mission requirements of the unit. Subsequent issues and changes are automatically distributed based on the list of equipment functional requirements furnished by using organizations. The distribution system enables direct shipment to the user, expediting delivery and eliminating the need for continuous review of publication indices and requisitioning. Requisitions are used only when replacement or additional copies of the automatically distributed publication are required.

(3) Distribution of other technical data is determined by requirements made known to the developer by other interested Agencies or Services, and is a responsibility of the developing or procuring agency.

(4) Standard guidelines for technical data distribution and the maintenance of files have been established within Department of Army Agencies by the Army Materiel Command.[2] Studies have been conducted in an attempt to make storage and retrieval systems compatible and to provide automated access by any interested Department of Army agency. One system studied by Picatinny Arsenal (Engineering Data Storage and Retrieval System) is in use by Picatinny, National Aeronautics and Space Agency, and U.S. Army Missile Command.

c. Navy

(1) The Chief of Naval Material is responsible for Navy data management programs and has delegated this function to the several Systems Commands where data management offices have been established. Navy policy requires that requests for contractor furnished data be reviewed with the objectives of obtaining only the data required, when required, and at the requisite time during the life cycle of the weapon system. Data requirements are developed from the operational and support concepts planned for the system and are used for the development of supply and maintenance requirements involved in the system life-cycle support. Review of data requirements is a continuous process in keeping with Secretary of Defense guidance. Each

[1] Department of Defense Instruction 5010.12, Management of Technical Data, 5 December 1968.
[2] Army Materiel Command Regulation 700-48, Improved Management and Determination of Requirements for Procurement of Technical Data and Information, 21 September 1966.

command distributes data to naval and other service agencies which have established requirements or who request specific data items. Systems Commands require that contractors prepare and maintain technical manuals during the production phase. Upon termination of the production phase, responsibility for technical manual changes is delegated to the appropriate Navy field activity where the changes are produced using organic capability.

(2) The Navy publications distribution system provides for automatic initial issue of required manuals and follow-on automatic distribution of those items for which using activities have a requirement. Replacement issues are made available through a requisitioning process. A system is established which enables units to obtain Army or Air Force publications applicable to Navy materiel.

(3) The Navy and Air Force have established an Interservice Technical Information Exchange System for rapid cross-reference and search of available technical publications.

d. Air Force

(1) The Air Force Logistics Command and the Air Force Systems Command share responsibilities for the technical data management program. The Air Force Systems Command is responsible for the initial data collection and distribution phase for new weapon systems, but operates in close coordination with the Air Force Logistics Command and the Air Force Training Command to insure development of data essential to the logistical support of systems once they are in operation. The Air Force Logistics Command manages the overall technical order program. Close, continuous liaison with Air Force Systems Command during the early design, development, and production phases is required. The Air Force Systems Command responsibility is that of developer and producer; The Air Force Logistics Command is that of logistics manager and as such includes review of maintenance requirements, tooling, and repair parts selection. Air Force Technical Orders are prepared by contract with hardware or publications contractors. Organic capability is used for preparation of Time Compliance Technical Orders, policy publications, and revisions to out-of-production manuals.

(2) Distribution of Technical Orders is managed by the Air Force Logistics Command through subordinate Air Materiel Areas, and is accomplished using both an automatic and a requisition-generated distribution system which compares with the systems used by the Army and Navy. Responsibility for operation of the distribution system rests with the Air Materiel Areas. Oklahoma City Air Materiel Area acts as the Air Force system manager for Technical Orders.

e. Marine Corps

(1) Publications which support Marine Corps material and equipment are issued and controlled under the Marine Corps Technical Publications Systems. The need for technical data within the Marine Corps is based upon operational planning factors leading to the requirement for a specific system or equipment. Follow-on requirements for data is considered in each phase of the life cycle of the item. Project officers determine the minimum data required to support each functional area.

(2) Publications are distributed through the use of individually tailored distribution lists. Appropriate manuals are provided to meet the requirements of the using unit, intermediate commands, and supply, maintenance, technical, and training support agencies.

(3) A Marine Corps Technical Data Repository for engineering data has been established at Philadelphia.[3] The repository may be expanded to include other forms of technical data as requirements dictate.

[3] Marine Corps Order 5210.12A, Marine Corps Central Data Repository, 27 September 1968.

3. COMPARISONS

a. All Services have:

(1) A program for portraying technical maintenance data and procedures for maintenance personnel based on the level of repair for which they are responsible.

(2) Established distribution systems to initially issue and periodically update technical publication libraries of using organizations. The systems are parallel in that organizations must indicate types of publications required with initial and subsequent distribution effected automatically once the requirements have been established.

(3) Established systems to enable users to comment on errors or discrepancies in technical publications.

(4) Assigned responsibility for data requirements determination and publications preparation to the major command having logistic responsibility. Services generally delegate to Project/System/Commodity Managers the responsibility for publication preparation, with printing and distribution responsibility retained at Service or major command level.

(5) A mutual urgent need in the structuring and presentation of data in a readable manner which will enable low-skilled personnel to maintain complex equipment in a timely, error-free manner.

b. The similarity of Service policies and procedures has facilitated the development of a joint manual to be applicable to any future multiservice aeronautical system development.[4] The manual covers the significant areas of publications support and preparation, but leaves internal distribution and detailed manual content and structure at the option of the Services.

c. The differences in Service technical publications are primarily due to Service policies pertaining to the distribution of work among the levels of maintenance.

d. Technical publications are identified as Technical Manuals by the Army, Navy, and Marine Corps and as Technical Orders by the Air Force.

4. STATUS

a. Office of the Secretary of Defense

(1) Technical Manual Specification and Standards Program. Under sponsorship of the Office of the Secretary of Defense standardization program, the Services are developing standard coordinated specifications used to procure technical manuals. This effort has produced specifications covering general requirements of format and style, printing, and the technical content requirements for commercial equipment, calibration procedures, and cargo aircraft loading and offloading. There are fourteen additional specifications in process, all covering technical content.

(2) Department of Defense Task Groups on Cross-Servicing Agreements for Technical Manuals. In 1966 the Assistant Secretary of Defense (Installations and Logistics), Office of Technical Data and Standardization, established a task group under chairmanship of the Air Force. The purpose of this task group was to develop cross-servicing agreements pertaining to the operations of the technical manual systems. Joint Army, Navy, Air Force, Marine Corps and Defense Supply Agency regulations have been published implementing the various agreements. The group has also prepared a list of technical manuals. This list contains the numbers of all the technical manuals used by more than one Service. This has been a further aid to cross-servicing efforts and avoids duplication in development and procurement of manuals having

[4] AMCP 700-4, NAVMAT-P-4000-1, AFLCM/AFSCM 400-4, Standard Integrated Support Management System, 18 March 1969.

potential for common use. In addition, an Inter-servicing Technical Information Exchange System is being developed to provide each Service with a computer tie-up to determine availability of Technical Manuals within the Department of Defense.

(3) Technical Manual Management Subcommittee of the Technical Data and Standardization Policy Committee. This committee is composed of representatives of each Service and is chaired by the Assistant Secretary of Defense (Installations and Logistics). The committee periodically meets to discuss all problems of mutual interest to the Services.

(4) Industrial Association Meetings. The major Industrial Associations have Service publications committees. These committees periodically meet with Government personnel to discuss technical manual management, coordinate on proposed specifications, and develop industry positions on special projects.

(5) The Department of Defense Equipment Maintenance and Readiness Council Ad Hoc Group on Evaluation of Various Automated Technical Data Systems. The efforts of this group represent the most promising step toward improvement of technical manuals yet seen. The group researched, consolidated, and evaluated the various Service programs for improvement. The recommendations of this group were submitted in May 1966 but have received little active attention since that time.

(6) Secretariat for Electronic Test Equipment. This is a scientific and technical information center operated by New York University under a contract administered by the Navy Electronics Systems Command. The project has been in operation since 1956 and provides scientific, technical, logistics and management types of information to the Services and other Government agencies in the special field of electronic tests, check-out, and support equipment.

b. Army

(1) Emphasis has been placed on use of new techniques for maintenance data presentation. It is recognized that no single technique may be suited for optimum use for all equipments or at all levels of use. Attention is also focused on improving the technical manual. For example, fault isolation logic flow charts, symptom collection charts, and tabular presentations are being used to a greater degree. Check lists for aircraft operators and preventive maintenance checks on card stock for aircraft technicians are in universal use.

(2) The Army Materiel Command Equipment Manuals Council, composed of representatives of all equipment publications preparing activities, meets periodically with the objectives of promoting more efficient management, increased competence of technical publications personnel, and improvement of maintenance data communications.

(3) The Army Ad Hoc Committee on Coordinated Equipment Publications was established in October 1968 to develop improved coordination of equipment publications among preparation, training, and using activities. One of the developments under consideration is to improve fault isolation procedures for incorporation into technical manuals.

(4) The Army initiated an internal service by which information is distributed in brochures describing new techniques proposed or used by industrial or governmental sources relative to preparation, storage, retrieval, display, and distribution of maintenance data. This information service has been expanded to include distribution to all military services.

(5) A field test and evaluation of a programmed maintenance manual (Symbolic Integrated Maintenance Manual (SIMM) for the HAWK guided missile has been completed. Field testing and evaluation of a miniaturized technical data system (Maintenance Information concerning The Repair and Operation of Missile Systems) is being conducted. This system involves display and print-out of information with the use of microfiche using manual retrieval.

(6) Field testing and evaluation of a pocket-size combat vehicle operator's manual is being performed. The test vehicle is the M551 SHERIDAN Weapon System. It is expected that such a manual can be used with similar types of equipment.

c. Navy

(1) Naval Air Systems Command has been directed to expand the microfilm concept (Maintenance Information Automatic Retrieval System (MIARS) for possible use throughout the Navy.[5] A coordinating group will establish the requirements necessary for presenting data on microfilm and the type of data retrieval mechanism (automatic or manual) that will be necessary for the data presentation. This group will also determine improved updating procedures and methods for incorporating corrections, revisions and changes. The concept of a technical manual system manager for maintaining, updating and distributing microfilm data is being explored.

(2) The Naval Air Systems Command has instituted a program (Documentation Improvement Program) aimed specifically at realizing improvements in the quality, readability, technical accuracy, and timeliness of technical documentation.

(3) Various systems such as The Weapon System Maintenance Action Center and Rapid Automated Problem Identification Data System are being explored in an effort to determine their adaptability for use in the Navy environment of aircraft maintenance. The filmed data technique, utilized by the Navy Aircraft Rework Facility at Naval Air Station, Jacksonville, consisting of filming the hard copy manuals in their present form, was also investigated. Present plans of the Maintenance Information Automatic Retrieval System Coordinating Group indicate that the requirements for the method of film presentation of data, the coding system for retrieval of filmed data, and the type of retrieval system will be a joint decision. After these factors are decided the types of hardware needed to meet these requirements can be determined.

(4) The Naval Air Systems Command has included a requirement for providing all technical data on microfilm in the procurement contracts for the F-14 aircraft. The method of presentation will be prescribed by the Coordinating Group. Microfilming techniques are becoming a part of all major Navy projects for the presentation of technical data.

(5) An Automated Ships Characteristics Card System is under development to provide responsive technical information for current ships characteristics to meet the needs of the fleet and Navy top management.

d. Air Force

(1) Large technical publications have been sectionalized as applicable for each maintenance specialty. Check lists containing brief steps in the order of accomplishment are being used to a greater extent. Logic Charts in manuals play an important part in the troubleshooting cycle.

(2) Included in the Air Force Technical Order System are automated technical orders in the form of punched cards and tapes. The use of the computer to troubleshoot is widespread in the Air Force. The tapes and programs that operate these computers along with the manuals that tell the mechanic what to do in each step of the test cycle represent an approach useful for certain applications.

(3) A Technical Order System Council was established in October 1968 for the purpose of periodically reviewing the Technical Order System. Each command in the Air Force is represented with the Air Force Logistics Command providing the chairman.

[5] Chief of Naval Operations Instruction 4790.1, Maintenance Information Automated Retrieval System (MIARS); Evaluation and Development of, 7 October 1968.

(4) Warner Robins Air Materiel Area is the test center for improved methods of presenting technical instructions and for coordination with the other Services and commercial suppliers on standardization matters and exchange of ideas on new presentation techniques.

(5) A test[6] conducted by the Air Force Systems Command and the Air Force Logistics Command indicated that changing the format of conventional technical orders could produce improved performance by maintenance technicians. In addition, the Air Force Human Resources Laboratory has been studying the problem of designing job performance aids for use with electronic equipment.

(6) Warner Robins and Oklahoma City Air Materiel Areas have test programs that place audio-visual, step-by-step assembly and disassembly procedures on film to be used by shop personnel in the overhaul of certain complicated components.

e. Marine Corps

(1) A feasibility study to determine the most practical microform for equipment maintenance publications is currently being conducted. The study provides for the use of microfiche, a Marine Corps adaptation of the system used by the Army for the SERGEANT Missile System.

(2) Two planned procurements incorporate the use of symbolic integrated maintenance manuals.

(3) Improved presentation techniques have been used for maintenance publications pertaining to printed circuit boards and radar sets.

f. General. The concept of built-in test equipment being exploited by all Services has a potential major impact on current technical manual contents. Fault isolation and diagnosis will be simplified and the need for detailed troubleshooting data in technical manuals will be reduced or eliminated. Service directed studies aimed at improving presentation techniques for technical data have been under way for several years.

5. IMPROVED TECHNIQUES AND CONCEPTS

a. Service-directed studies aimed at improving presentation techniques for technical data have been underway for several years. The goal of these studies has been to improve the usability of technical data while concurrently expediting distribution and updating. Techniques can be categorized as follows:

(1) Conventional or modified conventional manuals:

PYRAGRAM — Pyramid-Diagram proposed by Hughes Aircraft Company. Technique was used by Army for the Missile Integration Terminal Equipment Manuals.

DATOM — Data Aids for Training Operations and Maintenance proposed by General Electric for Navy use on sonar systems.

PIMO — Presentation of Information for Maintenance Operations proposed by Serendipity Corporation and used by the Air Force on a test basis with C-141 aircraft.

(2) Miniaturization

MICROCARD — Used by the Army for support of the SERGEANT missile system.

[6]Air Force Systems Command Test Report 69-155, Presentation of Information for Maintenance Operations (PIMO), May 1969.

MICROFICHE	Used by the Army for support of the PERSHING missile system.

(3) Programmed Manuals

MAINTRAIN	Maintenance and Training in complex equipment developed by Human Resources Research Office for test on NIKE and HAWK missile systems.
FORECAST	Proposed by Human Resources Research Office for possible Navy use in intermediate maintenance of electronic equipment.
SIMM	Symbolic Integrated Maintenance Manuals have been used in part for the PERSHING missile system and in full for a HAWK missile system test. Air Force has adopted this concept for support of ground communications - electronics.

(4) Data Retrieval Systems

WSMAC	Weapons System Maintenance Action Center. Uses microfilm to portray a programmed trouble-shooting technique.
MEMRI	Maintenance Engineering Management and Repair Information, a Republic Aviation proprietary technique applicable to electronic and mechanical equipment.

b. Of the approaches identified, only two modified conventional manuals and programmed manuals really address the problem of presenting in more usable form the data necessary to maintain equipment. The other systems assist in reducing bulk and expediting distribution and control. Current state-of-the-art permits conversion of hard-copy publications to microfilm, microfiche, or microcard for storage and retrieval in their current format. The area requiring further study, however, is the optimum method of restructuring and portraying data to enable personnel of lesser skills to perform maintenance operations at a relatively error-free rate. To this end, modified conventional manuals, programmed manuals, and data retrieval systems all have contributions to make, yet none are at the stage of development which would allow widespread use.

c. The automated technical data techniques under study have been focused on a particular aspect of the maintenance problems. Some concentrate on maintenance tasks, others are oriented toward troubleshooting solutions. Evaluation of the automated techniques tested to date in terms of suitability and dependability is extremely difficult, since no standard collection nor test objective approach has been used.

6. SUMMARY. The OSD and Services have initiated programs to improve management and exploit techniques for displaying technical data. The JLRB considered these efforts in connection with the Review and has no recommendation.

APPENDIX D
LIST OF ACRONYMS AND ABBREVIATIONS

ABFC	Advanced Base Functional Components
ADPS	Automatic Data Processing System
AFDL	Small Auxiliary Floating Drydock
AFDM	Medium Auxiliary Floating Drydock
AFLC	Air Force Logistics Command
AFM	Air Force Manual
AFRAMS	Air Force Recoverable Assembly Management System
AFSME	Director of Maintenance Engineering (HQ USAF)
AGE	Aerospace Ground Equipment
ALS	Advanced Logistics Systems
AMA	Air Materiel Area
AM&S	Aircraft Maintenance and Supply
APC	Armored Personnel Carrier
ARMMS	Automated Reporting Materiel Management System
ARMS	Automated Reporting Maintenance System
AUTODIN	Automatic Digital Network
CAMEL	Critical Aviation Material Expediting List
CCB	Configuration Control Board
C-E-M	Communications-Electronics-Meteorological
CER	Complete Engine Repair
CINC	Commander in Chief
CINCPAC	Commander in Chief, Pacific
CLS	Closed Loop Support
CMC	Commandant of the Marine Corps
CNM	Chief of Naval Material
CNO	Chief of Naval Operations

COCOAS	Conarc Class I Automated System
COMSERVPAC	Commander, Services Forces, Pacific
CONARC	Continental Army Command
CONEX	Container, Express
CONUS	Continental United States
COSTAR	Combat Service to the Army
CRITICPAC	A System of special monthly push shipments from CONUS to augment normal supply procedures for fast-moving routinely required supplies. Limited to 400 lbs per box.
CS 3	Combat Service Support System
CSP	Carrier Support Package
DA	Department of the Army
DAMS	Data Automated Maintenance System
DART	Depot Automatic Rescheduling Technique
DSCLOG	Deputy Chief of Staff for Logistics (HQ USA)
DIFM	Due in From Maintenance
DMMS	Depot Maintenance Management System
DOD	Department of Defense
DODD	DOD Directive
DODEMMIS	DOD Equipment Maintenance Management Information System
DODI	Department of Defense Instructions
DS	Direct Support
EDAC	Equipment Distribution and Condition
ESL	Essential Stockage List
FAMF	Floating Aircraft Maintenance Facility
FAWPRA	Fleet Air Western Pacific Repair Activity
FLC	Force Logistic Command
FMF	Fleet Marine Force
FMFPAC	Fleet Marine Forces, Pacific
FOB	Forward Operating Base
FSR	Force Service Regiment

GCA	Ground Control Approach
GS	General Support
GSE	Ground Support Equipment
HQMC	Headquarters, Marine Corps
ICE CUBE	In-Country Calibration Complex
ICP	Inventory Control Point
ILS	Integrated Logistic Support
IM	Inventory Manager
INAS	Industrial Naval Air Stations
IRAN	Inspect and Repair as Necessary
IRON	Inspect and Repair Only as Necessary
IROS	Increase Reliability of Operational Systems
I^2S	Marine Corps Integrated Information System
ISSA	Interservice Supply Support Agreement
JCS	Joint Chiefs of Staff
JLRB	Joint Logistics Review Board
LAAM	Light Antiaircraft Missile
LARC	Light Amphibious Resupply Cargo
LCO-P	Logistics Control Office-Pacific
LHA	Amphibious Assault Ship, General Purpose
LOGAIR	A schedule cargo airlift service operated by the Air Force Logistics Command over established routes within the continental United States.
MAC	Military Airlift Command
MACV	Military Assistance Command, Vietnam
MAF	Marine Amphibious Force
MAG	Marine Aircraft Group
MAP	Military Assistance Program
MARES	Marine Corps Automated Readiness Evaluation System
MATS	Military Air Transport Service
MCO	Marine Corps Order

MDC	Maintenance Data Collection
MDCS	Maintenance Data Collection System
MDR	Maintenance Data Record
MEMS	Maintenance Engineering Management System
MHA	Man-Hour Accounting
MHE	Materials Handing Equipment
MIARS	Maintenance Information Automated Retrieval System
MICROMS	Maintenance Information Concerning the Repair and Operation of Missile Systems
MIDA	Major Item Data Agency
MILSCAP	Military Standard Contract Administration Procedure
MILSTAMP	Military Standard Transportation & Movement Procedures
MILSTEP	Military Supply & Transportation Evaluation Procedure
MILSTRAP	Military Standard Transaction Reporting & Accounting Procedure
MILSTRIP	Military Standard Requisitioning & Issue Procedure
MIMMS	Marine Corps Integrated Maintenance Management Systems
MIP	Material Improvement Project
MIS	Management Information System
MISTR	Management of Items Subject to Repair
MMICS	Maintenance Management Information and Control System
MOB	Main Operating Base
MOCSY	Mechanized Maintenance Control System
MOD	Modification
MOS	Military Occupational Specialty
MRM	Maintenance Reporting Management
MSC	Marine Supply Center
MSL	Minimum Stockage List
MSO	Maintenance Support Office
MSP	Maintenance Support Positive
MTBF	Mean Time Between Failure

MTOE	Modification Table of Organization and Equipment
MUMMS	Marine Corps Unified Materiel Management System
NAPALM	National ADP Program for AMC Logistics Management
NAICOM/MIS	Navy Integrated Command/Management Information System
NARF	Naval Aircraft Rework Facility
NAVLIS	Navy Logistics Information Systems
NAVMAT	Naval Material Command
NAVSUPPACT	Naval Support Activity
NCO	Non-Commissioned Officer
NEC	Navy Enlisted Classification
NICRISP	Naval Integrated Comprehensive Reparable Item Scheduling Procedure
NOBC	Naval Officer Billet Classification
NOMIS	Naval Ordnance Management Information System
NORM	Not Operationally Ready—Maintenance
NOR	Not Operationally Ready
NORS	Not Operationally Reading—Supply
NRFI	Not Ready For Issue
NSA	Navy Support Activity - Navy Stock Account
NSD	Naval Supply Depot
OASIS	AMC Ownership and Accountability of Super High Dollar Value Secondary Items in the Overseas Theater Depots
OCAMA	Oklahoma City Air Materiel Area
OJT	On-the-Job-Training
O&M	Operations and Maintenance
OR	Operationally Ready
OSD	Office of the Secretary of Defense
PACAF	Pacific Air Force
PACER SORT	An Air Force Program to evaluate impact of reducing repair workloads in a combat environment. Involved study of F-y C tactical fighters or 12th TFW at Cam Ranh Bay, RVN, in 1967.

PAR	Progressive Aircraft Rework
PACAM	Punch Card Accounting Machine
PCS	Permanent Change of Station
PIMO	Presentation of Information for Maintenance and Operation
PME	Precision Measurement Equipment
PMEL	Precision Measurement Equipment Laboratory
PMS	Planned Maintenance System
POA	Pacific Ocean Area
PRAM	Preliminary Repair Level Decision Analysis Model
PMS	Planned Maintenance System
PWR	Pre-positioned War Reserve
RAM	Rapid Area Maintenance
RAPCONS	Radar Approach Controls
RASS	Rapid Area Supply Support
RVN	Republic of Vietnam
SAC	Strategic Air Command
SATS	Short Airfield for Tactical Support
SCRAM	Special Criteria for Retrograde of Army Materiel
SEA	Southeast Asia
SECNAV	Office of the Secretary of the Navy
SIMM	Symbolic Integrated Maintenance Manual
SIMMS	Standard Integrated Maintenance Management System
SMR	Sources, Maintenance, and Recoverability Code
SNMMMS	Standard Navy Maintenance and Material Management System
SOAP	Spectrometric Oil Analysis Program
SPEED	System-wide Project for Electronic Equipment at Depots
SPEEDEX	Speed Extended
SRA	Specialized Repair Activity
SSM	System Support Manager
STRAAD	Special Techniques for Repair and Analysis of Aircraft Damage

STRAF	Strategic Army Force
TAC	Tactical Air Command
TAERS	The Army Equipment Record System
TAMMS	The Army Maintenance Management System
TASTA-70	The Administrative Support Theater Army - 70
TCTO	Time Compliance Technical Order
TDA	Tables of Distribution and Allowances
TDY	Temporary Duty
TE	Table of Equipment
TECH DATA	Technical Data
TERO	Tactical Equipment Repair Order
TM	Technical Manual
TO	Table of Organization
T.O.	Technical Order
TOC	Tactical Operations Center
TOE	Table of Organization and Equipment
TRUMP	Total Revision and Upgrading of Maintenance Procedures
UADPS	Uniform Automatic Data Processing Systems
UER	Unsatisfactory Equipment Report
USAMC	U.S. Army Materiel Command
USAREUR	U.S. Army, Europe
USARPAC	U.S. Army, Pacific
USARV	U.S. Army, Vietnam
VDM	Vehicle Deadlined for Maintenance
VDP	Vehicle Deadlined—Parts
WESTPAC	Western Pacific
WPAFB	Wright-Patterson Air Force Base
WRAMA	Warner-Robbins Air Materiel Area
WRM	War Readiness Materiel
WRSK	War Readiness Spares Kit

3M	Maintenance and Materiel Management
3M Program	Standard Navy Maintenance Material Management Program

NAVY SHIP AND CRAFT

AD	Destroyer Tender
AE	Ammunition Ship
AF/AFS	Store Ship/Combat Store Ship
AFDL	Small Auxiliary Floating Dry Dock (nonself-propelled)
AFDM	Medium Auxiliary Floating Dry Dock (nonself-propelled)
AGMR	Major Communications Relay Ship
AGTR	Technical Research Ship
AH	Hospital Ship
AKS	Stores Issue Ship
AO/AOE	Oiler/Fast Combat Support Ship
AOG	Gasoline Tanker
APL	Barracks Craft (nonself-propelled)
AR	Repair Ship
ARD	Auxiliary Repair Dry Dock (nonself-propelled)
ARG	Internal Combustion Engine Repair Ship
ARL	Landing Craft Repair Ship
AS	Submarine Tender
AV	Seaplane Tender
CA	Heavy Cruiser
CVA	Attack Aircraft Carrier
CVA (N)	Attack Aircraft Carrier (nuclear propulsion)
CVS	ASW Support Aircraft Carrie
DD	Destroyer
DER	Radar Picket Escort Ship
LCC	Amphibious Force Flagship
LCU	Landing Craft, Utility

LFS	Amphibious Fire Support Ship
LKA	Amphibious Cargo Ship
LPA	Amphibious Transport
LPD	Amphibious Transport Dock
LPH	Amphibious Assault Ship
LSD	Dock Landing Ship
LST	Tank Landing Ship
MSO/MSC	Minesweeper, Ocean/Minesweeper, Coastal (nonmagnetic)
PAC	Patrol Air Cushion Vehicle
PBR	River Patrol Boat
PCF (Swift)	Patrol Craft Inshore
PG	Patrol Gunboat
PTF	Fast Patrol Boat
SS	Submarine
WHEC	High Endurance Cutter (Coast Guard)
WPB	Patrol Craft (85 feet) (Coast Guard)
YFN	Covered Lights (nonself-propelled)
YFNB	Large Covered Lights (nonself-propelled)
YHLC	Salvage Lift Craft, Heavy
YLLC	Salvage Lift Craft, Light
YMLC	Salvage Lift Craft, Medium
YR	Foating Workshop (nonself-propelled)
YRBM	Repair, Berthing and Messing Barge (nonself-propelled)

APPENDIX E

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